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STANDARDIZATION OF TIKITIKI EXTRACT

By A. J. HERMANO
Of La Tondeña Distillery, Manila

and

PANTALEON J. AGUILA
Of the Bureau of Science, Manila

FIVE TEXT FIGURES

Although for more than two decades tikitiki extract has been recognized and prescribed for the treatment of beriberi in the Philippines, the degree of potency in vitamin B_1 units, as determined by a biological assay, has not been officially standardized. In the Philippines there are sold a number of brands of tikitiki extract made by various manufacturers. These different brands vary considerably in their physical properties and chemical composition, and particularly in their potency to prevent and to cure infantile beriberi and to protect adults from beriberi.

The object of this paper was (*a*) to define and establish standard requirements for the raw material (rice bran, rice polishings, or darak) used for making tikitiki extract; (*b*) to establish standard requirements for the vitamin B_1 potency in units of locally prepared extracts; and finally (*c*) to develop a local official biological assay method for determining the vitamin B_1 potency of tikitiki extracts as an aid to the enforcement of the Pure Food and Drugs Act.

Tikitiki extract is used extensively in the prevention and cure of infantile beriberi and to some extent in the cure of malnutrition in adults. Studies in beriberi were begun about three decades ago, when this deficiency disease causing a high death rate was rampant in the Philippine Islands. When Vedder and Williams(1) reported that rice polishings contained beriberi-preventing substances, the Bureau of Science began, in the latter part of 1913, the manufacture of tikitiki extract as a remedy to prevent and to cure infantile beriberi. Del Rosario and Marañon(2) reported the physicochemical evaluation of tikitiki extract in 1919. In 1921 Wells(3) published an improved method for the manufacture of tikitiki extract.

The biological test for vitamin B_1 in the rice bran extract prepared by the Bureau of Science was made by Santos and Collado(4) in 1925. These workers reported that 0.5 cc of the extract was sufficient to supplement the lack of vitamin B_1 in the deficient basal ration of rats. Hermano and Anido(5) later published their investigation on the chemical and biological analysis of seven brands of tikitiki extract. They noted that when 0.2 cc of the extract was added daily to a basal ration deficient in vitamin B_1, the ration contained sufficient vitamin B_1 to support a growing rat.

Gargaritano, Valenzuela, and Hermano(6) published their results on the biological assay (pigeon method) of the different brands of tikitiki extracts. They reported that the amount of tikitiki extract that will cure polyneuritic pigeons ranges from 0.025 to 0.050 cc. In the same year Hermano(7) reported his concurring results that the curative dose of tikitiki extract on beriberi pigeons was between 20 and 30 milligrams.

In August, 1917, Administrative Decision No. 170-a of the Board of Food and Drugs Inspection defined and established chemical standard requirements for a tikitiki extract. About fourteen years later, September 30, 1931, the Board of Pharmaceutical Examiners and Inspectors modified the Administrative Decision by approving Resolution No. 10, specifying that a sweetening agent may be added to the extract. The amount or percentage of the sugar which might be used to dilute the tikitiki extract was not stated. The essential standard requirement for the tikitiki extract that is still wanting in the Philippines for official regulation is the vitamin B_1 potency in units. The therapeutic value or strength of the extract is mainly dependent upon this principal constituent.

MATERIALS AND EXPERIMENTAL PROCEDURE

The materials used for this investigation consisted of the crude rice bran employed in the manufacture of tikitiki extract in the Bureau of Science, the International Standard Vitamin

B; received from Dr. E. M. Nelson, Senior Chemist, Bureau of Chemistry and Soils, Washington, D. C., the extract of rice polishings prepared by the Bureau of Science, Manila, and eight other commercial brands of tikitiki extracts.

Crude rice bran, locally called "tikitiki," or "darak," is the product removed during the process of pounding and polishing unpolished or hulled rice kernels. According to West and Cruz(8) rice bran (polishings) comprises the seed coat, germ, and most of the outer (aleurone) layer, with some of the starchy material beneath the aleurone layer. West and Cruz recommend that rice polishings of standard quality to produce excellent tikitiki extract must contain at least 20 per cent fat, calculated on a moisture-free basis. The presence of this fat or rice-bran oil is also a criterion for the quality of the crude rice bran, because it indicates the absence of adulterants, like hulls or other foreign substances.

Tikitiki extract of the Bureau of Science is a concentrated aqueous preparation (1 cc — 14.50 grams rice bran) made from fresh clean rice bran that has no mold or other signs of deterioration and contains no foreign substances. Analysis of an average sample of the Bureau of Science tikitiki extract shows the following:(5)

BUREAU OF SCIENCE TIKITIKI EXTRACT

Specific gravity at 27.5° C		1.3189
Total solids	per cent	70.37
Ash	do	3.54
Nitrogen	do	1.21
Reducing sugars before inversion	do	28.35
Reducing sugars after inversion	do	29.09
Nonreducing sugars	do	1.27
Phosphorus as P_2O_5	do	1.68
Alkalinity of ash in 100 grams	g. KOH	0.34
Qualitative analysis of ash for basis and acidic radicals		Ca, Mg, K. Na, Cl, and S.

Chemical analyses of nine brands of tikitiki extract were made in order to have on record the different physical properties and chemical composition of these products as manufactured by various laboratories. As shown by the data in Table 1, it would be rather difficult to establish the chemical constants as standards of purity, because they vary considerably, possibly due to the quality of the rice bran, which may be fresh and pure, or adulterated, deteriorated, or excessively attacked by larvæ and weevils.

TABLE 1.—*Analysis of Philippine tikitiki extracts.*

Constituents and constants.	Samples.			
	1	2	3	4
Specific gravity at 28.5° C.	1.32353	1.31091	1.32161	1.25000
Dried extract in grams per 10 cc heated to 90° C.	7.06	7.59	5.23	6.16
Phosphorus as P_2O_5 ... per cent	0.815	1.005	0.909	0.736
Ash ... do	8.52	7.31	5.10	6.51
pH value	5.81	6.31	5.93	5.95
Reducing sugars before inversion ... per cent	35.10	29.15	23.55	18.70
Reducing sugars after inversion ... do	36.27	29.36	25.20	31.97
Sucrose ... do	1.17	9.80	1.65	13.27
Total protein ... do	3.18	4.19	3.77	3.25
Alkalinity of ash as $N/10$ HCl from 5 grams tikitiki extracts ... cc	3.265	2.65	3.18	2.66
Analysis of ash.	Ca, Mg, K, Na Phosphate Sulphate Chloride	Ca, Mg, K, Na Phosphate Sulphate Chloride	Ca, Mg, K, Na Phosphate Sulphate Chloride	Ca, Mg, K, Na Phosphate Sulphate Chloride

Constituents and constants.	Samples.				
	5	6	7	8	9
Specific gravity at 28.5° C	1.28002	1.21263	1.30165	1.3167	1.3526
Dried extract in grams per 10 cc heated to 90° C	6.82	4.20	6.25	8.2900	8.7096
Phosphorus as P_2O_5 per cent	1.005	0.8347	0.802	2.01	2.18
Ash do	9.20	8.63	8.80	7.05	5.68
pH value	5.60	4.96	5.20	Not determined	Not determined
Reducing sugars before inversion per cent	17.18	22.99	20.051	22.72	36.41
Reducing sugars after inversion do	20.77	29.99	35.32	41.71	40.22
Sucrose do	3.60	5.97	16.26	19.01	4.67
Total protein do	3.89	1.88	8.92	13.49	11.95
Alkalinity of ash $\frac{N}{10}$ HCl from 5 grams tikitiki extract cc	2.125	4.02	6.45	Not determined	Not determined
Analysis of ash	Ca, Mg, K, Na Phosphate Sulphate Chloride	Ca, Mg, K, Na Phosphate Sulphate Chloride	Ca, Mg, K, Na Phosphate Sulphate Chloride	Ca, Mg, K, Na PO_4, SO_4, Cl	Ca, Mg, K, Na PO_4, SO_4, Cl

According to the report of the International Vitamin Conference(9) on vitamin standardization held in London from June 12 to June 14, 1934, the International Standard Vitamin B_1 is an acid-clay adsorption product of rice bran extract. Ten milligrams of this standard is equivalent to one unit.

Albino rats bred at the Bureau of Science were used for the vitamin experiments. Healthy young animals, 25 to 29 days of age, and weighing 25 to 39 grams, were selected and placed in individual metal cages.

The basal ration used for the experiments was as follows: Casein, 18 grams; butter fat, 8; purico (hydrogenated coconut oil) 6; cod liver oil, 5; agar-agar, 2; a salt mixture (No. 185) 4; and dextrin, 57. Casein, butter fat, and dextrin employed in the basal ration were prepared and purified according to the methods(10) previously published. The salt mixture was McCollum's No. 185, and the drinking water was obtained from an artesian well. This basal ration is practically free from vitamin B_1, and contains not only adequate but approximately optimal amounts for growth of rats in other respects.

The rats were divided into five groups consisting of three to five rats each. These experimental rats were fed with a basal ration free of vitamin B_1 and were weighed every two or three days. The weight curve for each animal was plotted in charts. After losing sufficient weight as a result of the lack of vitamin B_1 in the basal ration, the rats manifested characteristic symptoms of beriberi, or vitamin B_1 deficiencies, such as knotty tail, coarse hair, hunchback, and emaciation of the legs.

The first group consisted of five albino rats, placed in five separate metal cages. The growth curves of the animals are shown in text fig. 1. When the symptoms of vitamin B_1 deficiency became apparent, each animal was given daily 10 milligrams of International Standards Vitamin B_1.

Five rats were used in the second group; the chart of the growth curves is shown in text fig. 2. Each rat, after manifesting symptoms of beriberi or vitamin B_1 deficiency, was given daily 40 milligrams of tikitiki extract, Bureau of Science brand. The effect of the treatment is illustrated in text fig. 2.

The third group consisted of three rats whose growth curves before and after treatment were plotted as shown in text fig. 3. When the symptoms of vitamin B_1 deficiency and beriberi became apparent, each animal was given daily 50 milligrams of tikitiki extract, Bureau of Science brand; the results are recorded in text fig. 3.

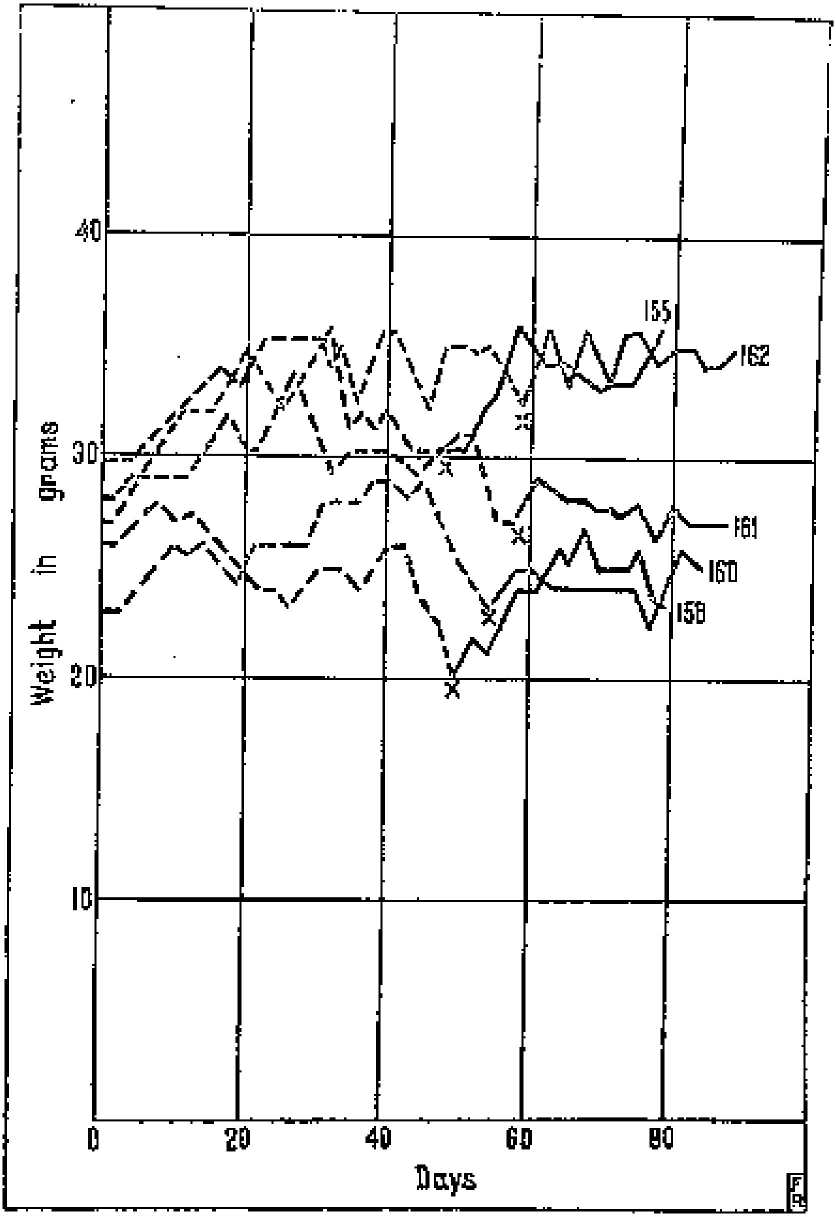

FIG. 5. Weights of albino rats Nos. 155, 158, 160, 161, and 162, fed with the basal ration until beriberi was produced. From the point X each white rat received daily ten milligrams of International Standard Vitamin B_1 in addition to the basal diet. The animals did not gain the desired weight of 5 grams a week. Broken line: Before administration of vitamin B_1; solid line: After administration of vitamin B_1.

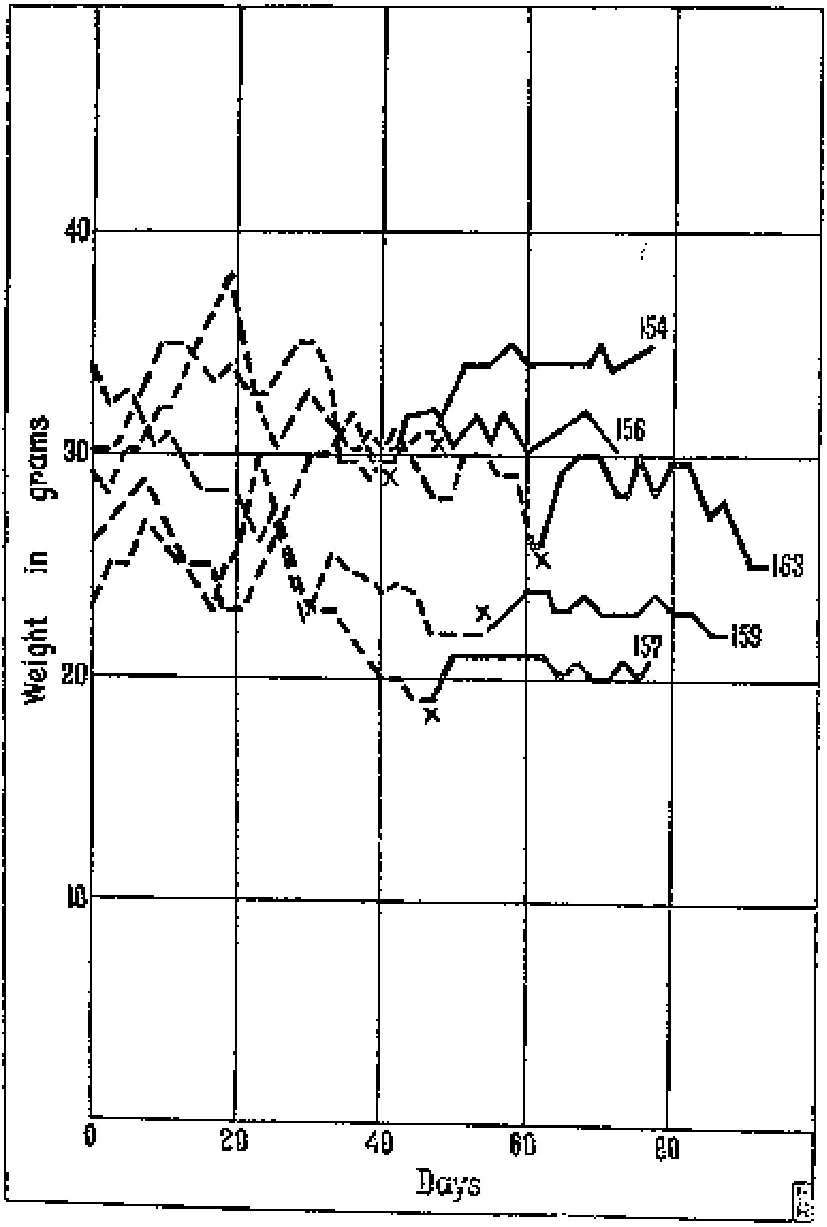

FIG. 2. Weights of albino rats Nos. 154, 156, 157, 159, and 163, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 40 milligrams of Bureau of Science tikitiki extract in addition to the basal diet. The amount was insufficient to supplement the deficient basal ration. Broken line: Before administration of vitamin B_1; solid line: After administration of vitamin B_1.

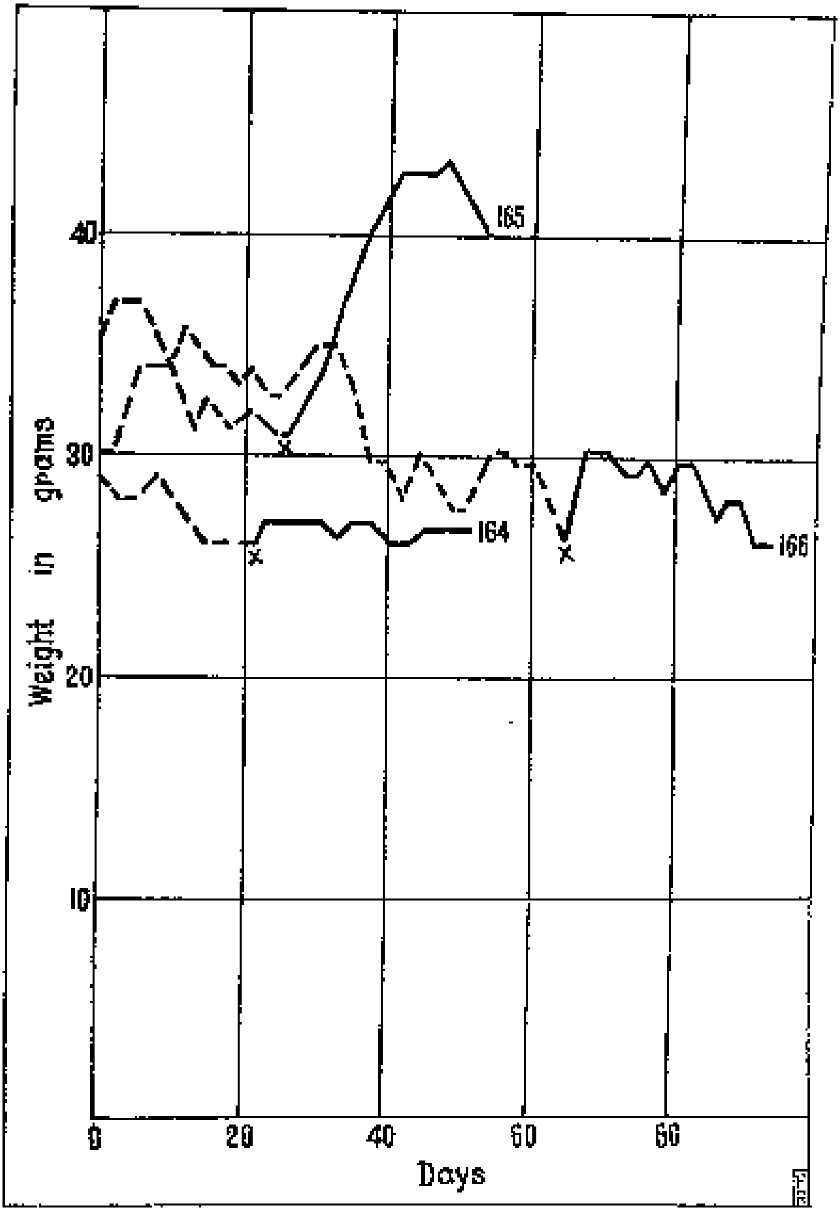

FIG. 3. Weights of albino rats Nos. 164, 165, and 166, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 60 milligrams of Bureau of Science tikitiki extract in addition to the basal diet. The results showed that the dosage was insufficient to supplement the basal ration. Broken line: Before administration of vitamin B_1; solid line: After administration of vitamin B_1.

The fourth group contained three rats whose growth curves before and after treatment were plotted as shown in text fig. 4. After each rat showed definite symptoms of beriberi and vitamin B_1 deficiency, it was fed daily 0.05 cubic centimeter of tikitiki extract, Bureau of Science brand. The effects of the extract were remarkable.

The fifth group consisted of three albino rats. Crude rice bran, the raw material employed in the manufacture of tikitiki extract in the tikitiki plant of the Bureau of Science, was used to counteract vitamin B_1 deficiency in this group. When the rats manifested definite symptoms of beriberi and deficiency in vitamin B_1 as noted on the chart curves, each animal was fed daily 0.725 gram of rice bran. The results of the feeding were plotted in text fig. 5.

DISCUSSION AND RESULTS

In the course of the experiments the time required to produce the symptoms of beriberi and vitamin B_1 deficiency in the rats was variable, as shown by the growth curves plotted in text figs. 1 to 5. The period of 30 days is considered sufficient to cure beriberi and vitamin B_1 deficiency, and to cause their symptoms gradually to disappear. The rats then appeared to be normal again, showing that the dosage or supplement to the basal ration was satisfactory and sufficient.

Out of the five albino rats in the first group that were given or fed daily 10 milligrams each of the International Standard Vitamin B_1, four animals were able to maintain their weight with very slight increase but were not cured. One rat maintained its weight almost the same as when the treatment was started. Ten milligrams of International Standard Vitamin B_1 are considered equivalent to one International Unit. The animals did not gain the desired weight of 3 grams a week.

From the five animals in the second group that were each given daily 40 milligrams of the Bureau of Science tikitiki extract, two maintained their weight almost constantly throughout the treatment. The remaining three rats had a very slight increase in weight, an average of 0.077 gram per day. The results showed an insufficiency in the amount of extract required to supplement the deficient basal ration.

One of the three rats in the third group that were each given daily 50 milligrams of the Bureau of Science tikitiki extract was cured of beriberi with a gain in weight of 2.10 grams per week. Another showed improvement, and the third maintained

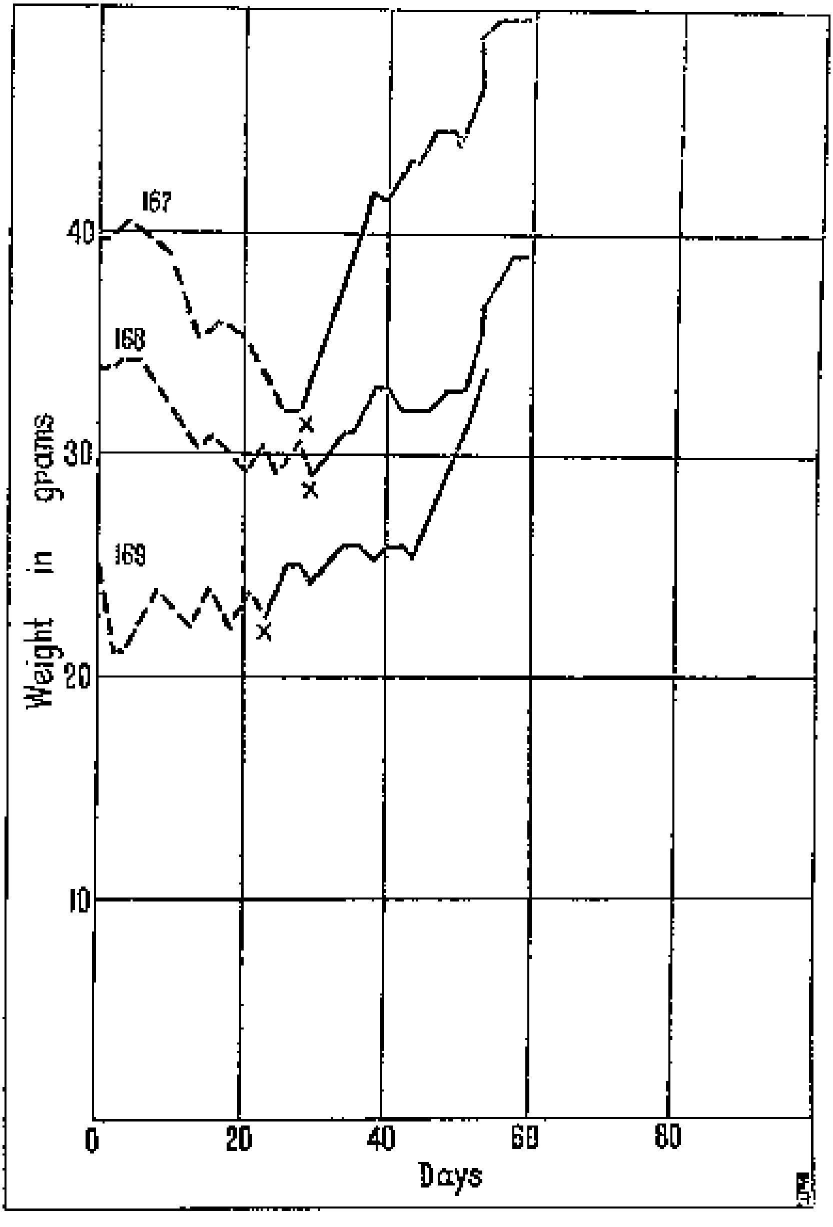

FIG. 4. Weights of albino rats Nos. 167, 168, and 169, fed with the basal ration free of vitamin B₁ until beriberi was produced. From the point X each white rat received daily 0.05 cubic centimeter of Bureau of Science tikitiki extract in addition to the basal diet. Each rat showed an average weekly gain in weight of 3.536 grams, equivalent to more than one International Unit. Broken line: Before administration of vitamin B₁; solid line: After administration of vitamin B₁.

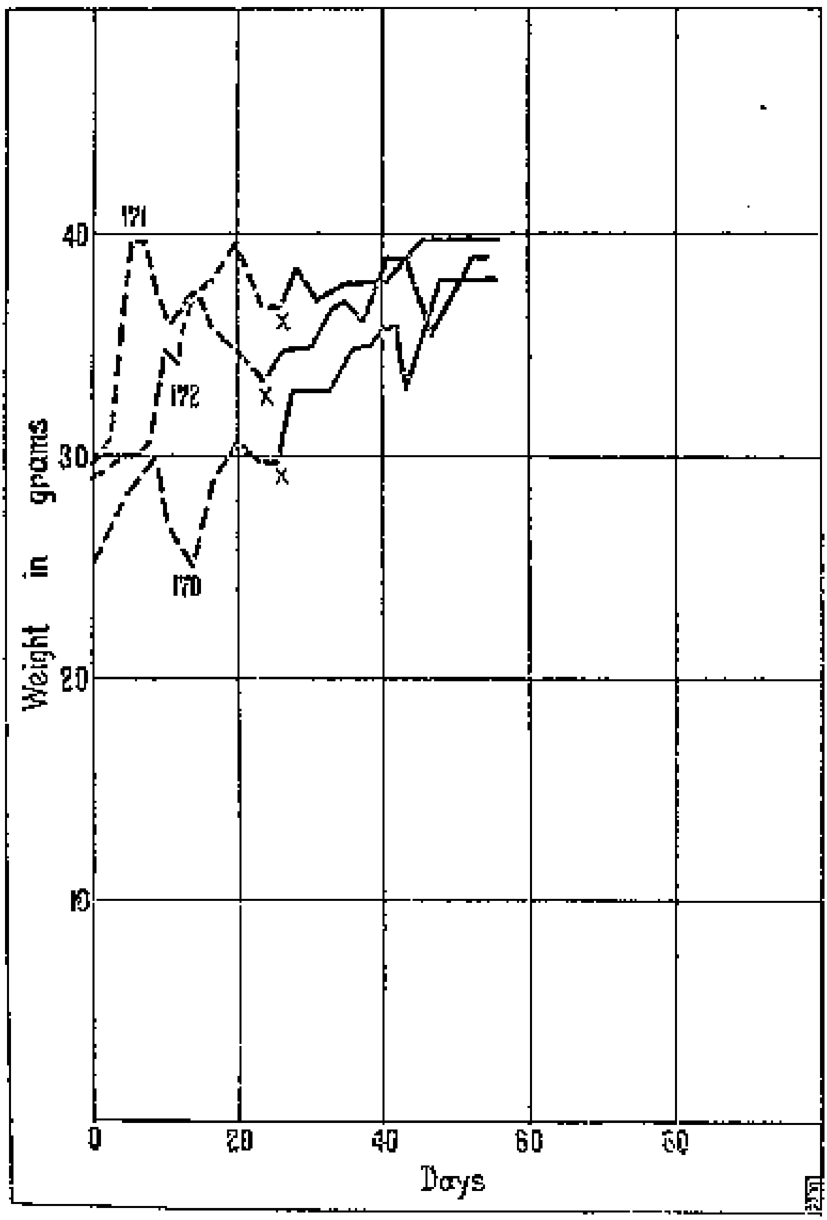

FIG. 6. Weights of albino rats Nos. 170, 171, and 172, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 0.726 gram of crude rice bran in addition to the basal diet. The results showed that the amount was insufficient to supplement the deficient basal ration. Broken line: Before administration of vitamin B_1; solid line: After administration of vitamin B_1.

its weight almost constant. The average gain in weight a week of the three rats was 0.80 gram, showing insufficient dosage to supplement the basal ration.

The three albino rats in the fourth group that were ill with symptoms of vitamin B_1 deficiency and that were fed daily 0.05 cubic centimeter of tikitiki extract, Bureau of Science brand, recovered completely, becoming normal and very active. Each rat showed an average weekly gain in weight of 3.336 grams, equivalent to more than one International Unit.

In evaluating the crude rice bran used in the manufacture of tikitiki extract, its potency for vitamin B_1 content was determined by the same method. On the basis of the yield of extract from rice bran (14.5 grams of the rice bran produces 1 cubic centimeter of extract) calculation shows that the potency of 0.05 cubic centimeter of tikitiki extract is equivalent to that of 0.725 gram of crude rice bran.

According to the growth curves (text fig. 5) the amount (0.725 gram) of crude rice bran was not sufficient to supplement the deficiency, and to produce the average gain in weight of 3 grams weekly.

SUMMARY AND CONCLUSION

Chemical analyses were made of nine brands of tikitiki extract manufactured by different local laboratories and drug stores.

Biological analyses were also made of the crude rice bran and the tikitiki manufactured by the Bureau of Science, Manila.

The dosage of 10 milligrams of International Stanlard Vitamin B_1 or an equivalent of one International Unit, did not produce an average gain in weight of 3 grams weekly in albino rats. The discrepancy may be due to the breed of albino rats used or to the effect of prevailing climatic conditions on the metabolism of the rats.

The dosage of 40 to 50 milligrams of tikitiki extract, Bureau of Science brand, fed daily to albino rats, gave results comparable with those obtained by using 10 milligrams of International Standard Vitamin B_1.

The dosage of 0.05 cubic centimeter of the Bureau of Science tikitiki extract was found to be equivalent to one International Unit. The average weekly gain in weight of each albino rat was 3.336 grams.

Since a dosage of 0.725 gram of crude rice bran was insufficient to supplement the deficiency of vitamin B_1, and produced an effect equivalent to one International Unit, it was assumed that one gram of rice bran fed daily is sufficient to effect a weekly gain in weight of 3 grams.

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ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Weights of albino rats Nos. 155, 158, 160, 161, and 162, fed with the basal ration until beriberi was produced. From the point X each white rat received daily 10 milligrams of International Standard Vitamin B_1 in addition to the basal diet. The animals did not gain the desired weight of 3 grams a week. Broken line: Before administration of vitamin B_1. Solid line: After administration of vitamin B_1.

2. Weights of albino rats Nos. 154, 156, 157, 159, and 163, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 40 milligrams of Bureau of Science tikitiki extract in addition to the basal diet. The amount was insufficient to supplement the deficient basal ration. Broken line: Before administration of vitamin B_1. Solid line: After administration of vitamin B_1.

3. Weights of albino rats Nos. 164, 165, and 166, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 50 milligrams of Bureau of Science tikitiki extract in addition to the basal diet. The results showed that the dosage was insufficient to supplement the basal ration. Broken line: Before administration of vitamin B_1. Solid line: After administration of vitamin B_1.

4. Weights of albino rats Nos. 167, 168, and 169 were fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 0.05 cubic centimeter of Bureau of Science tikitiki extract in addition to the basal diet. Each rat showed an average weekly gain in weight of 3.336 grams, equivalent to more than one International Unit. Broken line: Before administration of vitamin B_1. Solid line: After administration of vitamin B_1.

5. Weights of albino rats Nos. 170, 171, and 172, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 0.725 gram of crude rice bran in addition to the basal diet. The results showed that the amount was insufficient to supplement the deficient basal ration. Broken line: Before administration of vitamin B_1. Solid line: After administration of vitamin B_1.

STUDIES ON THE ANATOMY OF THE BAÑGOS, CHANOS CHANOS (FORSKÅL), I

THE SKELETAL SYSTEM

By Dioscoro S. Rabor

Of the Fish and Game Administration, Bureau of Science, Manila

TEN PLATES AND ONE TEXT FIGURE

The milkfish, *Chanos chanos* (Forskål), locally known as bañgos, is the most common food fish in the Philippine Islands, where its culture is one of the most important phases of the fishing industry. Strangely enough very little is known about its anatomy. The present paper is a study on the skeletal system of the species.

Ridewood(5) in his work on the osteology of the skull of clupeoid fishes wrote that the accessory branchial organ of *Chanos* has been briefly alluded to by Müller in his work "Bau und Grenzen der Ganoiden"[1] and described and figured by Hyrtl, although its relation to the rest of the skeletal parts were not shown.[2]

Ridewood's work on the osteology of the skull of *Chanos salmoneus* describes briefly, with drawings, the most important features of this fish in contrast to those of the other members of the clupeoid group.

In the present work 7 specimens, taken from fishponds, and ranging in length from 30 to 35 centimeters, and one marine specimen, 50 centimeters long, were dissected in detail for the study of the different parts of the skeletal system. In addition, 11 pond-raised specimens were examined for the vertebral skeleton. In this study the number of abdominal and caudal vertebræ, ribs, and fin rays were noted.

Ridewood's(5) system of grouping the different elements of the skull and visceral skeleton into series or sets was followed in the present work. The grouping is rather artificial in some respects, but it has been found very convenient in the discussion of relationship between the different bones.

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[1] Berlin (1846) 74, 75.

[2] Denkschr. Akad. Wiss. Wien 21 (1863) 1-10, pl. 1.

The nomenclature of Starks(7) is followed as closely as possible, with some minor exceptions.

A summary of the different bones and their possible total number on both sides is appended at the end of the discussion. Plate 6, fig. B, figures the complete skeleton, with all the skeletal elements on the right side intact, while those of the left side are detached and grouped accordingly.

SKULL AND VISCERAL SKELETON

Cranium (Plates 1 and 2; text fig. 1).—The term cranium, as applied here, includes the complex of not readily separable bones situated around the brain. It includes the vomer and parasphenoid, which morphologically belong to the maxillary and mandibular arches, but for convenience in discussion are included in this group.

The cranium is broad and flattened. The anterior part, at the region of the snout, is seemingly divided equally by a very narrow strip of bone, an upward and backward process of the vomer (Plate 1, *1*) which meets the rounded projecting middle part of the ethmoid. The main body of the vomer lies ventrally, forming the roof of the anterior part of the mouth. The bone when disarticulated presents a keeled dorsal surface, the keel fitting snugly into the chondrocranial cartilage of the ethmoid plate. The posterior part is prolonged into a sharply elongated keeled process, fitting exactly in the groove of the likewise keeled anterior portion of the parasphenoid. The vomer is toothless.

The ethmoid (Plate 1, *2*) lies behind the vomer on the dorsal surface of the skull. It is butterfly-shaped, with the anterior tips of the winglike processes projecting laterally from the rounded median body. Posteriorly the hind tips are overlapped by the anterior portions of the succeeding frontal bones (Plate 1, *4*).

The prefrontal (Plate 1, *3*) bones are situated behind and below the ethmoid, projecting anterolaterally on each side. The two bones do not meet medially. They are firmly embedded in the cartilages of the ethmoid plate and the trabecular portions of the chondrocranial elements.

Between the orbits, dorsally, are the broad flat frontal bones (Plate 1, *4*) joined in the middle by a suture. They form the biggest portion of the roof of the skull. They are roughly right-triangular in shape, with the right angles formed by the median suture and the posterior borders, and the most acute angle formed by the lateral and medial borders, of the bone which overlaps the posterior part of the ethmoid. The anterior portions are quite far apart, showing the cartilage layer which separates these bones from the prefrontal below.

On each side of the cranium and immediately below the preceding bones is the sphenotic (Plate 1, *5*) with its laterally projecting process. Each sphenotic forms the upper posterior border of the eye cavity. Some authors call these bones postfrontals. One half of the anterior outer half of the articulating surface for the hyomandibular (*16*) is borne on the ventral edge of the sphenotic.

Immediately behind the middle portion of the posterior border of each frontal and partially overlapped by it, lies the small parietal (Plate 1, *6*). The left and right parietals are widely separated, but a sensory-canal scale of the transverse commissural system on each side usually fuses with each of them and they with each other, producing a false union over the supraoccipital (*8*). Morphologically the scales belong to the lateral line system and not to the cranium proper. In three quite young specimens dissected the scales were easily separable from the parietals proper; in the other five specimens the two elements were well fused, appearing as single bones on each side.

The epiotic (Plate 1, *7*) lies immediately behind each of the preceding bones. Obliquely and medially, it meets a posterolateral limb of the supraoccipital. Laterally, it sends out a limb meeting the dorsomedial limb of the pterotic (*9*). Ventrally it meets the ventromedial portion of the pterotic, the dorsolateral wing of the exoccipital (*11*), and the dorsal limb of the opisthotic (*10*). The epiotic forms a sharp angle on the dorsal portion of the cranium on either side of the supraoccipital spine (Plate 1, *sup cr*; text fig. 1, *sup cr*).

Forming the most posterior element on the dorsal part of the cranium and separating the two parietals, lies the median supraoccipital (Plate 1, *8*). Posteriorly it is prolonged into a supraoccipital crest, more fittingly called supraoccipital spine. This spine projects posteriorly and divides into two sets of brushlike fine bony filaments of from 8 to 12 on each side. The brushlike bony filaments are situated between the left and right sets of epaxial muscles. The supraoccipital forms the dorsal portion of the brain-case backwall.

The pterotic (Plate 1, *9*) forms the posterior angle on each side of the skull and is produced into a spine sloping backward, outward, and downward, and extending down to the posterior end of the posttemporal (*54*). On its ventrolateral region it bears the posterior half of the articulating surface of the hyomandibular. Of all the elements of the cranium, the pterotic articulates with the most bones. Anterodorsally it meets the frontal and the parietal; dorso- and ventromedially, the epiotic; ventromedially, the exoccipital; anteroventrally, the sphenotic; ventrolaterally, the prootic (*15*) and exoccipital; and posteroventrally, the opisthotic.

The opisthotic (Plate 1, *10*) is a small bone applied closely to the ventromedial region of the pterotic spine of each side. It meets the epiotic dorsally and the exoccipital medially. This bone is easily removed with the removal of the posttemporal, the tip of its opisthotic limb being well joined by fibrous connections with the opisthotic.

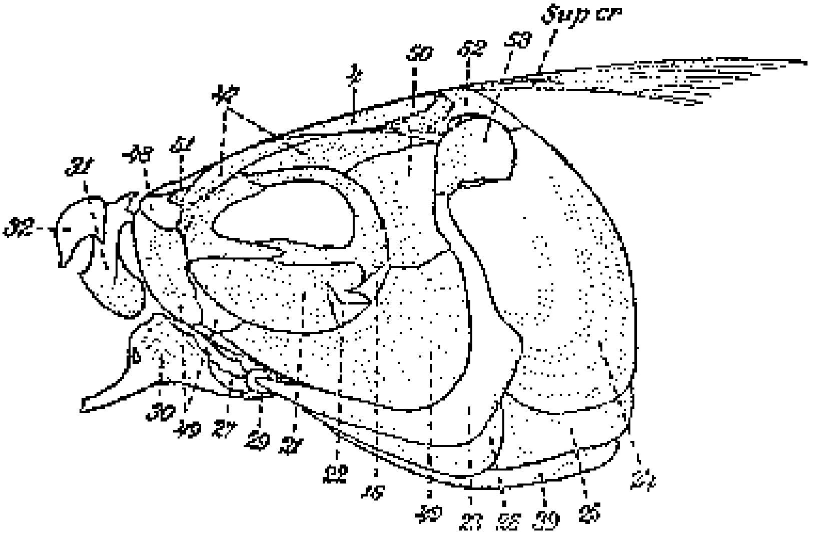

FIG. 1. Skull, left lateral aspect; × 1.5. 4, frontal; 16, hyomandibular; 21, mesopterygoid; 22, metapterygoid; 23, preopercle; 24, opercle; 25, subopercle; 26, interopercle; 27, articular; 29, angular; 30, dentary; 31, maxillary; 32, premaxillary; 39, branchiostegal; 46, supraorbitals; 48, preorbital; 49, suborbitals; 50, postorbital; 51, nasal; 52, supratemporal; 53, subtemporal; sup cr, supraoccipital crest or spine.

The remaining portion of the brain-case backwall is formed by the exoccipital (Plate 1, *11*) bones which lie closely together along the median line, immediately below the supraoccipital. The bone on each side is prolonged into a pointed plate which slopes upward and backward, and meets the other plate in the median line, forming a roof which fits over the neural arch of the first vertebra. It affords a safe protection for the hind portion of the brain and the immediately succeeding portion of the spinal cord. The anterodorsal wing of the bone, as stated above, forms the remaining portion of the hind wall of the brain case; the anteroventral wing, the hinder portion of the floor of the brain case. Each bone possesses a facet at the point of junction of its three wings. These facets lie very close together in the median line but do not fuse totally, forming the anterior floor of the foramen magnum (Plate 2, *for mag*). Each facet has a ventral and a posterior articulating surface, the former for the articulation of the real basioccipital (*12*) and the latter for the reception of the half centrum which has come to be a part of the basioccipital.

The basioccipital (Plate 1, *12*) is the single median bone forming the posteromedian ventral region of the floor of the brain cavity. It also forms the floor of the foramen magnum, and directly receives the articulation of the vertebral column by means of its half centrum.

Anteriorly articulated with the vomer and posteriorly with the basioccipital, the narrow elongated parasphenoid (Plate 1, *13*) extends into the median ventral region of the cranium, forming the posterior portion of the roof of the buccal cavity. The bone is sharply bent at about the middle of its length. At this point there is an oval depression on its ventral surface for the reception of the suspensory cartilage (Plate 5, *45*) of the branchial apparatus. At the same level on either side, the ascending dorsal wings rise moderately in front of the prootics.

The anterolateral wall on each side of the brain case is formed by the alisphenoid (Plate 1, *14*). Dorsomedially each bone sends out a limb which is closely applied to the ventral surface of the frontal. These two limbs connect with each other by means of a cartilaginous plate, which in turn connects posteriorly with the anterior border of the supraoccipital. This plate can be clearly seen if the frontals are detached. Posteriorly, the alisphenoid is closely applied to both the sphenotic and the prootic. Ridewood(5) in his description of the skull did not mention the presence of the alisphenoid, nor did he include the bone in the labelling of his figures.

There are no basisphenoid and orbitosphenoid bones.

Forming the anteroventrolateral walls of the brain case on each side are the prootics (Plate 1, *15*), which establish connection with each other in their middle portions by means of medial limbs which meet in the median line forming the anterior portion of the floor of the brain cavity. At the same time they form the roof of the myodome or eye-muscle canal.

The back portion of the cranium is much hollowed out, presenting a median depression just between the two epiotics. On each side of this median depression is a large, completely roofed-in cavity, known as the posterior temporal fossa. The median depression is filled up in life by thick trunk muscles which are divided into left and right sets by the brushes of the supraoccipital spine. The posterior temporal fossa ends blindly, anteriorly. Its inner wall is formed by the supraoccipital and the epiotic; its sloping roof, by the frontal, parietal, pterotic, and epiotic; its floor and outer wall, by the sphenotic and pterotic. The fossa is likewise filled up in life by muscles which extend up to its very anterior portions.

Immediately dorsal to the projecting process of the sphenotic is the lateral temporal groove, roofed over by the frontal and the pterotic. In life this groove is filled up with muscles.

The articulating surface for the hyomandibular slopes downward and forward, seemingly making an acute angle, directed posteriorly, with the lateral temporal groove. The articulating surface is borne on the sphenotic, pterotic, and prootic.

Immediately below the brain case and separated from it by the fused medial wings of the prootics is the myodome or eye-muscle canal. The wall on each side is formed by the descending wing of the prootic, and its floor, by the parasphenoid. The canal ends blindly posteriorly.

Temporal and preopercular series (*Plates 3 and 4; text fig. 1*).—The supratemporal (Plates 3 and 4; text fig. 1, *52*) is a flat scalelike bone found on the hind portion of the skull immediately over the space formed by the epiotic limb of the posttemporal and the pterotic spine. It is easily removed with the thick skin of the head. It is roughly triradiate in shape and bears on its surface a corresponding triradiate sensory canal. One branch goes upward, connecting with the sensory canal borne by the sensory-canal scale of the transverse commissural system which has come to fuse with the parietal; another goes posteriorly and connects with the canal of the posttemporal; the last goes anteriorly downward, connecting with the canal borne by the bone below, the subtemporal.

The subtemporal (Plate 3; text fig. 1, *53*), is a flat, scalelike thin bone, overlapping the anterosuperior portion of the opercle (Plate 3; text fig. 1, *24*). It bears near its anterior border a sensory canal which continues downward into the preopercle.

The posttemporal (Plates 3 and 4, *54*) is a small rounded bone with two limbs, a dorsal epiotic and a ventral opisthotic limb.

The tip of the dorsal limb fits snugly in a groove on the epiotic and supraoccipital bones. The ventral limb, as stated previously, articulates rather firmly with the opisthotic bone, its connection being strengthened by fibrous attachments. The body of the bone is so sculptured that it fits exactly into the corresponding sculptured tip of the supraclavicle (Plates 3 and 4, *55*), resulting in the tendency of the two bones to fuse. Most writers include the posttemporal and supratemporal with the elements of the pectoral girdle. The present work adopts the same idea, but for convenience in discussion they are artificially grouped with the bones of the skull.

The preopercle (Plate 3; text fig. 1, *23*) is a large curved bone which fits closely over the anterior border of the broad opercle. It has along its anterior edge a sensory canal which is connected with the canal of the subtemporal. It is covered to a large extent by some elements of the circumorbital series.

The interopercle (Plate 3; text fig. 1, *26*) lies immediately below the preceding bone and is partly covered by it. It has a sensory canal along its ventral border.

The bones of the preopercular series are sensory-canal bones, differentiated from the opercle and subopercle which are not.

Circumorbital series (Plate 3; text fig. 1).—There are usually eight elements in the circumorbital series, forming a complete orbital ring, which include two supraorbitals (Plate 3; text fig. 1, *47*), one postorbital (Plate 3; text fig. 1, *50*), three suborbitals (Plate 3; text fig. 1, *49*), one preorbital (Plate 3; text fig. 1, *48*), and one nasal (Plate 3; text fig. 1, *51*). In two specimens a triangular flake is separated off the upper border of the postorbital, making the number of the series on the left side nine instead of eight, although the number on the right side is normal. This variation, however, has no special significance.

The anterior element of the supraorbital is a thick curved bone, very unlike the other bones of the series which are normally thin and scalelike.

The nasal (text fig. 1, *51*) is very small, situated in front of the anterior tip of the thickened supraorbital and easily overlooked in dissection.

Sensory canals are found in most of the elements of the circumorbital series.

Maxillary series (Plate 3).—Both elements of the maxillary series, the premaxillary (Plate 3; text fig. 1, *32*) and the maxillary (Plate 3; text fig. 1, *31*) are short and broad, very much reducing the gape. Normally only the premaxillary bounds the buccal opening above, the anterior portion of the maxillary being well hidden by the former. Both are thin and curved bones with sharp lower edges but devoid of teeth.

The maxillary is partly hidden by the most anterior suborbital elements and can only be fully seen when the mouth is forcibly opened wide.

There is no surmaxillary.

Mandibular series (Plates 3 and 4; text fig. 1).—The dentary (Plate 4; text fig. 1, *30*) is a curved rod anteriorly and a broad irregularly shaped plate posteriorly, both portions being devoid of teeth. On its inner side are closely applied the articular (Plates 3 and 4; text fig. 1, *27*) and the tiny but distinct sesamoid articular (Plate 4, *28*), the latter lying on the anterodorsal part of the former. Cartilaginous elements, the remains of Meckel's cartilage, make the articular appear thicker than it actually is. The posterior portion of the articular can be distinctly seen through the notch in the posterior border of the coronoid process of the dentary. The articular bears the articulating surface on its posterior part. Immediately below this point the small but very distinct angular (Plate 4; text fig. 1, *29*) is attached.

Hyopalatine series (Plates 3 and 4).—The hyomandibular (Plates 3 and 4; text fig. 1, *16*) articulates with the cranium by a single elongated head. Its upper edge, instead of being horizontal, slopes downward and forward. At about one-third of its length downward, on its posterior border, is a well-rounded head for the articulation of the opercle. Along its entire length on the outer surface, near its posterior border, the bone is produced into a curving ridge producing a well-defined hollow for muscle attachments. Nearer the ventral half and directed anteriorly is a spiny process which touches the metapterygoid (*22*), visible from the outside on the hind wall of the eye cavity (text fig. 1, *16*). The inner surface of the bone is flat.

Attached to the distal portion of the hyomandibular is the narrow and elongate symplectic, and above it, the moderately broad metapterygoid. A thin but strong transparent membrane stretches in the space between these two bones.

The symplectic (Plates 3 and 4, *17*) meets the elongated spine-like posterior process of the quadrate (Plates 3 and 4, *18*) along the lower border of its anterior half. The quadrate is placed so far forward as to almost separate completely from the symplectic and metapterygoid, perhaps in close relationship to the reduction of the buccal opening. The quadrate articulates with the articular at the lower angle of its anterior broad portion.

The main body of the thin, flat, and almost transparent pterygoid, (Plates 3 and 4, *19*) lies immediately behind the expanded portion of the quadrate. It is prolonged anteriorly into a rod which is closely applied to the ventral border of the palatine (*20*) for nearly its whole length. The posterior angle of the pterygoid extends beyond the quadrate and can be discerned from the outer aspect through the thin transparent membrane stretching between the quadrate and the contiguous bones. It is clearly seen from the inner aspect of the series. Its tip merely touches the metapterygoid border.

The palatine (Plates 3 and 4, *20*) is a thick bone whose anterior tip fits into a depression in the cartilage of the ethmoid region, immediately lateral to the vomer. It becomes expanded posteriorly, and articulates with the whole anterior border of the mesopterygoid.

The mesopterygoid (Plates 3 and 4; text fig. 1, *21*) is a thin and almost transparent bone forming the main floor and wall of the orbit. Posteriorly it articulates with the bony metapterygoid.

The main body of the metapterygoid (Plates 3 and 4; text fig. 1, *22*) is of the same size and shape as the quadrate. A medial process meets the posterior border of the mesopterygoid but can be clearly distinguished from this bone. The process can be seen externally in the hind wall of the orbit.

Opercular series (*Plates 2 and 3; text fig. 1*).—The opercle (Plate 3; text fig. 1, *24*) is the broadest and most prominent bone on the lateral part of the skull. Its anterosuperior border is partly hidden by the subtemporal, and the whole of its anterior border is covered by the preopercle. It possesses a prominent articulating socket on the inner surface of its upper anterior portion, for the reception of the corresponding head in the hyomandibular.

Immediately ventral to the opercle and partly concealed by it is the curving subopercle (Plate 3; text fig. 1, *25*). It curves forward and upward into a sharp spine provided with a groove along its posterior edge which receives the anteroventral edge of the opercle as if spliced together with it. Frequently these two bones come off together in a single piece, the more ventral subopercle appearing like a mere ventral extension of the opercle.

Below the subopercle and mostly covered by it is the most posterior and outermost branchiostegal (Plate 2; text fig. 1, *39*). There are four branchiostegals on each side, gradually diminishing in breadth and becoming more pointed mesially. They are all flat, thin, and lamellate. The two inner elements are attached to the lower half of the outer face of the ceratohyal (*35*), the two outer bones, to the same region in the epihyal.

The elements of the opercular series grade off regularly into the subopercle and opercle, while the preopercle and interopercle seem not to fit in it.

Hyobranchial series (*Plates 2 and 5*).—There is no mistaking the hyoid portion of the hyobranchial series, because it is the most anterior in position and much stouter in structure than the rest.

The glossohyal (Plates 2 and 5, *37*), forming the framework of the tongue, projects forward from the median region of the hyoid, immediately between the closely articulated two-layered hypohyals (*36*). It is mainly cartilaginous, but the posterior half is covered by a thin membrane bone which extends a little backward, covering the anterior portion of the 1st basibranchial.

There are two sets of hypohyals (Plates 2 and 5, *36*), one on top of the other. The dorsal parts are roughly circular in form and smaller in size than the ventral set.

The ceratohyal (Plates 2 and 5, *35*) extends backward and outward from the hypohyals, followed still more posteriorly by the epihyal (Plates 2 and 5, *34*) which is in length roughly only one-half the ceratohyal. The most posterior tip of the epihyal, a little nearer the dorsoposterior border, bears a small nodule of cartilage, the interhyal (Plates 2 and 5, *33*), which articulates the ventral half of the hyoid arch with its dorsal half, the hyomandibular.

The large urohyal (Plates 2 and 5, *38*) articulates with the posterior median portion of the hypohyals. Posteriorly it comes in close contact with the anterior border of the clavicular parts of the pectoral girdle, in such an intimate manner that its dorsal ridge merges gracefully into the median ridge formed by the clavicles (*56*).

There are three basibranchials (Plate 5, *40*), the 1st and 2d of about equal size, and the 3d the largest of them all. A small flake of bone develops over the cartilage in the posterior half of the 1st basibranchial (Plate 5, 40_1), partly covering the anterior portion of the 2d. The 2d basibranchial (Plate 5, 40_2) possesses a similar flake of bone in the same region as the 1st, which in turn partly covers the anterior part of the 3d. The 3d basibranchial (Plate 5, 40_3) is very much enlarged by the fusion with it of the bases of the 3d hypobranchials (Plate 5, 41_3). The lines of fusion, however, can easily be discerned, especially in the inferior aspect of the branchial apparatus.

There are three pairs of hypobranchials (Plate 5, *41*) one pair attached to each of the three basibranchials. They gradually diminish in length posteriorly, the 1st pair (41_1) being the longest and the 3d (41_3) the shortest.

There are five pairs of ceratobranchials (Plate 5, *42*), the first three pairs being directly joined to the three corresponding hypobranchials and the last two pairs directly and indirectly to the posterior portions of the 3d basibranchial by means of median cartilage strips. The 4th (Plate 5, 42_4) and 5th ceratobranchials (Plate 5, 42_5) are greatly modified, having their posterior portions greatly enlarged, in accordance with the modifications suffered by the other parts in this region for the support of the branchial apparatus. The two 5th ceratobranchials are fused along the greater part of their length, proximally, forming a median symphysis. Their posterior portions are separate, and together with the expanded bases of the 4th are attached to a broad plate of combined cartilage and membrane. From this plate two broad cartilaginous processes extend backward and upward, forming the real backwall of the branchial region.

Four pairs of epibranchials (Plate 5, *43*) join the first four ceratobranchials by means of long cartilaginous connections which permit of certain movement. The 4th pair (Plate 5, 43_4) are very much modified, each one possessing in its dorsal extremity a backwardly projecting process which is joined to the main body by a broad transparent membrane. This is another modification to support the branchial organs.

Three pairs of small and slender cartilaginous pharyngobranchials (Plate 5, *44*) articulate with the dorsal extremities of the first three corresponding pairs of epibranchials. Each of the 4th epibranchial pair joins the slender medial bony process which projects from near the dorsal extremity of the 3d epibranchial, and also establishes cartilaginous connections with the 3d pharyngobranchials.

On each side all three pharyngobranchials unite with each other by means of cartilaginous connections; anteriorly both sides join and are prolonged into the suspensory cartilage (Plate 5, *45*) which suspends the dorsal parts of the branchial apparatus to the parasphenoid.

The inner surfaces of the hypobranchials, ceratobranchials, and epibranchials bear numerous fine gillrakers of moderate length, and their posterior outer surfaces bear the gill filaments.

VERTEBRAL COLUMN AND RIBS

Vertebral column (Plate 6, fig. A; Plate 7; Plate 9; Plate 10).—Jordan(2, p. 205) reported seventy-two vertebræ in *Chanos chanos*. In the present study so far only forty-three vertebræ were found as the common normal number for the species, with forty-four as a variation having been found in three of the nineteen specimens studied. The sole marine specimen dissected possessed forty-four vertebræ.

The vertebral column is divisible into an anterior, abdominal, region and a posterior, caudal, region. The presence of a complete hæmal arch was used as the criterion for distinguishing the caudal vertebræ (Plates 6, *66*, and 7) from the real abdominal vertebræ (Plate 6, *65*). In one specimen a complete hæmal arch was formed on the 17th vertebra; in thirteen specimens, including the marine form, on the 18th; and in another five specimens, on the 19th vertebra. On the basis of the above facts, there must be from sixteen to eighteen abdominal vertebræ and from twenty-five to twenty-seven caudal vertebræ, including the last or hypural vertebra.

After the first two abdominal vertebræ the remainder bear movable ribs (Plates 6 and 7, *74*); the first twelve to fifteen caudal vertebræ also bear movable ribs.

Plate 7 shows the structures of vertebræ taken from different levels of the vertebral column. Plate 7, fig. H, is a typical abdominal vertebra (the 11th), with the parts disarticulated to show details (front view). The roughly cylindrical dice-box-shaped centrum (Plate 7, *67*) is deeply concave at both the anterior and posterior faces, with a tiny hole perforating its center in an anteroposterior direction. The edges of adjacent centra are joined together by ligaments, the junction being further strengthened by articulations between little bony processes, the zygapophyses (Plate 7, *72*). From about the 18th vertebra until the 40th, four sets of such zygapophyses enter in the articulation of succeeding centra, the dorsal anterior and posterior neural zygapophyses and the ventral anterior and posterior hæmal zygapophyses. These are very clearly seen in the typical caudal vertebra (Plate 7, fig. G). In the fresh specimen the resulting cavity between two successive centra is filled up with a gelatinous substance, the remains of the primitive notochord.

The neurapophyses (Plate 7, *68*) are attached to the dorsal surface of the centrum, by ligamentous articulation in the anterior fifteen or sixteen vertebræ and by permanent ankylosis in the remaining posterior vertebræ. The left and right neurapophyses meet in the median dorsal portion, forming the neural arch, which encloses the neural canal. The neural arch is prolonged dorsad and backward into the neural spine (Plate 7, *69*) which may be single or double, depending on the extent of union of the neurapophyses. In the first six or seven vertebræ the neural arches can be totally separated into distinct right and left elements with their corresponding neural spines. This condition results in the presence of double neural spines in the vertebræ concerned. The remaining posterior vertebræ possess single neural spines with the tips of the first few spines cleft to show the remains of fusion. The spines are all directed backwards and dorsad and are longest in the region of the 25th to the 31st vertebræ.

Attached to the ventrolateral regions of the centrum are projections known as parapophyses (Plate 7, *73*) for the articulation of the ribs. They are biggest on the 3d vertebra and gradually diminish in size and prominence posteriorly until the 16th or 18th vertebra, when with the formation of the first complete hæmal arch they disappear. Correspondingly, the ribs of the first sixteen or eighteen vertebræ are articulated to the parapophyses. Posteriorly they are attached to the sides of the developing hæmal arches, and more backwards until the last rib-bearing vertebra (30th or 31st), they are borne on the still diverging tips of the newly-formed hæmal spine (Plate 7, *71*).

The epipleurals (Plate 7, *75*), or double ribs, are attached to the dorsolateral regions of the centrum by fibrous connections.

Typical caudal vertebræ are pictured in Plate 7, figs. F and G. A typical caudal vertebra does not possess ribs or epipleurals. The hæmapophyses (Plate 7, *70*) are joined together ventrally, forming the hæmal arch which encloses a canal, the hæmal canal. The arch is prolonged downward and backward into a hæmal spine.

The first vertebra, the atlas (Plate 7, fig. A) is modified for the articulation of the vertebral column with the half centrum of the basioccipital. The centrum is smaller than the centra of the more posterior vertebræ. The neurapophyses are the broadest in the whole column. The neural spine as stated previously is double. There are beginnings of the parapophyses on its ventrolateral regions, although in younger specimens these cannot be seen. Between the bases of the neurapophyses and the centrum the delicate epipleurals are articulated.

The second vertebra, the axis (Plate 7, fig. B), is also differentiated from the others and closely resembles the atlas in structure. The neurapophyses, although smaller than those of the atlas, are larger than those of the succeeding vertebræ. The neural spine is likewise double. The parapophyses are always present. The axis possesses a pair of epipleurals.

The 3d vertebra (Plate 7, fig. C), is more of a typical abdominal vertebra with all its parts, than the first two. The ribs are the biggest in the whole column. The neural spine is double.

Plate 7, fig. D, is the 17th vertebra, or last abdominal vertebra. The structure is similar to that of the typical vertebra already described above.

Plate 7, fig. E, is the 18th, or the 1st caudal vertebra. Except for the complete hæmal arch and the corresponding attachment of the ribs to the bases of this structure instead of to the parapophyses which are no longer present, the vertebra resembles in many respects the typical abdominal vertebra.

Plate 7, fig. F, is the 32d, or the 2d real caudal vertebra with no movable ribs attached.

Plate 7, fig. G, is the 31st, or the 1st real caudal vertebra, showing the structures from the lateral aspect.

The last four or five caudal vertebræ are included in the attachment of the caudal fin. The last three vertebræ, especially, are well modified. The neural arches and spines are very much enlarged. Just at the point of fusion of the neurapophyses of the 41st vertebra there is a prominently projecting anterior process which fits tightly into the back of the neural arch of the preceding vertebra. The hæmal arch possesses a similar projecting anterior process, also at the point of fusion of the hæmapophyses, which likewise fits tightly into the back part of the hæmal arch of the preceding vertebra.

The neural arch and spine of the 42d vertebra possesses the same anterior process at the same place. In addition to this, there is an interneural which fits tightly between the neural spines of the 41st and 42d vertebræ. In two specimens, instead of these modifications, there were two neural arches and spines for the 42d vertebra. The hæmal arch with its spine is very much enlarged and is movably articulated with the centrum.

The 43d or hypural vertebra is the most modified of all the vertebræ (Plate 10, figs. D and E). The centrum tapers obliquely upward and backward, and continues imperceptibly into the neural arch and its spine. The elements of the neurapophyses are separate. The hæmal arch with its spine suffers the same modification as that of the 42d vertebra, only that its base rises more obliquely upward, corresponding to the modified nature of the centrum.

These different modifications and specialized arrangements of the last few caudal vertebræ result in a strong rigid articulation of these structures, and yet permit a certain degree of movement corresponding to the movements demanded of the caudal fin.

There are six hypurals (Plates 6 and 10, *81*) which differ remarkably in size. The 1st hypural is small and slender, and fits tightly between the last neural spine and the 2d hypural. The 2d hypural is a little larger than the 1st and articulates with the curving upturned base of the 3d hypural. The 3d hypural is large, and articulates with a posterior projection from the base of the neural arch of the 43d vertebra. The 4th hypural is a little larger than the 3d, and articulates with the tapering tip of the centrum of the 43d vertebra. The 5th hypural articulates with both the centrum and the most posterior tip of the base of the hæmal arch of the 43d vertebra. This and the 4th hypural form the middle portion of the caudal fin skeleton. The 6th hypural is the largest and broadest of all the hypurals. It articulates with the hæmal arch and spine of the 43d vertebra.

All the hypurals as shown by the 4th and the 6th, have the tendency to be wedge-shaped. The whole set together with the last few vertebræ are greatly strengthened by cartilage reënforcements.

Ribs (Plates 6, 7, and 9).—Movable ribs (Plates 6 and 7, *74*), or subperitoneal ribs, are found on the twenty-eighth or twenty-ninth vertebræ after the axis. They encircle the abdominal cavity and are situated immediately under its parietal peritoneum. There is a gradual decrease in the length and breadth of the ribs from the first pair to the last. The span between the pairs remains practically the same throughout the first thirteen or fourteen pairs and then gradually becomes less posteriorly until the last six or seven pairs, where the elements of both sides come close together nearly in a parallel line. This variation in the span of the ribs corresponds to the gradual decrease in the size of the abdominal cavity as it proceeds posteriorly. The last four pairs of ribs are modified in position to support more efficiently the posterior portion of the air bladder.

Epipleurals (*Plate 9, figs. C and D*).—At the junction of the epaxial and hypaxial muscles, along the myocommata and in the plane of the embryonic horizontal skeletogenous septum, the paired epipleurals (Plate 7, 75) are situated. As has been stated previously, they are attached by fibrous connections to the dorsolateral regions of the centra of the first twenty-three to twenty-six vertebræ.

Two strong tendon bones project backward and outward from each side of the occipital region, their course roughly parallel to that of the subperitoneal ribs. The second of these two bones is very much enlarged, and possesses several slender branches which are spread among the muscles of the anterior part of the trunk (epaxial region) in the manner of the multiple filamentous branches of the intermuscular bones. It arises from the dorsolateroposterior part of the basioccipital, or, to be exact, at that region of the basioccipital half centrum. The first bone is much smaller than the second, but is still considerably larger than any of the real epipleurals. It arises at the proximal portion of the posterolateral region of the exoccipital. In a well-prepared skull they are not detached and seem to be a real part of it. Ridewood(5) considered them as intermuscular bones. These two bones help form the support of the roof of the bronchial region and at the same time support the thick muscles at the back of the skull. From their function, location, and structure, they are halfway between the real epipleurals and the intermusculars (Plate 9, figs. A and B), so I propose to call them epipleurointermuscular bones.

The real epipleurals are borne by the vertebræ, beginning with the atlas, to the 23d or 26th; consequently, twenty-one to twenty-four vertebræ, except the atlas and axis, bear double ribs. The first fifteen to nineteen pairs are usually bifid, with the dorsal branch going along the curve of the epaxial muscles, and the ventral, in the direction of the hypaxial muscles. The remaining epipleurals are delicate slender single pieces which decrease in length in the posterior vertebræ. In the last four or five epipleurals the ossification has not been completed, so that their proximal portions are still fibrous and only a small portion of the distal end is ossified. Sometimes this ossified portion is only about 1 mm long, and, of course, easily overlooked in dissection. The number of epipleurals on both sides varies, but this variation is not significant.

GIRDLES AND FINS

Shoulder girdle and fins (*Plate 3; Plate 4, figs. B and D*).—The uppermost bone of the shoulder girdle is the supratemporal (Plates 3 and 4; text fig. 1, *52*) which is followed ventrally by the posttemporal (Plate 4, *54*). These two bones of the temporal series have already been dealt with. Both serve to connect the remaining ventral elements of the shoulder girdle to the skull, although the latter, through its dorsal epiotic limb and ventral opisthotic limb, performs the greater part of the work.

Below the posttemporal, extending downward and backward, is the slightly curved flattish supraclavicle (Plates 3 and 4, *55*), shaped like the blade of a knife. Its entire posterior border is thin and sharp. Its posterior third is closely but not immovably applied to the outer anterior border of the ascending dorsal limb of the clavicle.

The clavicle (Plates 3 and 4, *56*) is long and runs forward and downward. Its curving ventral portion is expanded mesially, the thin expanded portions of both clavicles closely meeting but not totally fusing in the median line, producing a prominent ridge.

Behind the base of the clavicles at the curve, the small, thin, and slender scalelike postclavicle (Plates 3 and 4, *57*) is slightly attached. Its posterior end is also applied closely along the whole length of the short posterior dorsal spine of the hypercoracoid (*58*), somewhat strengthening its slight attachment. It extends backward and downward through the muscles of the base of the pectoral fin. Unless great care is taken in the dissection of these parts, the postclavicle is easily lost.

Two irregularly flat bones, the hypercoracoid (Plates 3 and 4, *58*) and the hypocoracoid (Plates 3 and 4, *59*) the former slightly smaller and placed posterodorsad of the latter, are immovably articulated with the clavicle. The former articulates with the clavicle by means of a broad anterodorsally directed limb, and with its mate, through its ventral region. It possesses a large foramen on its anterior part. The hypocoracoid articulates with the base of the clavicle in two places; posteriorly, by means of a posterodorsal projection which meets a similar posteroventral projection of the clavicular base, and anteriorly, through its pointed anterior tip which meets an anteroventral projection of the clavicle.

A slender and curved mesocoracoid (Plate 4, *60*), visible only on the medial side of the girdle, serves to join the last three elements of the girdle.

Articulating with the hypercoracoid and the hypocoracoid and directed posteriorly are four or five small bones, the actinosts (Plates 3 and 4, *61*), which, except the two dorsal cuboid elements, are all irregularly slender.

The fifteen to seventeen cartilaginous pectoral rays (Plate 4, *62*) articulate with the actinosts by means of cartilaginous nodules which are firmly fixed and held between their widely diverging bases. The number of rays may slightly vary on each side.

Pelvic girdle and fins (*Plate 3; Plate 4, figs. C and D*).—The skeletal support of the ventral fins is entirely free from the rest of the skeletal system. The ventral fin on each side is supported by a single bone, the pelvic girdle (Plates 3 and 4, *63*). Each bone possesses a medially directed posterior projection which meets that of the other side in the median line and is joined to it by cartilage. The ten to twelve ventral rays (Plates 3 and 4, *64*) are indirectly attached to the girdle by similar cartilaginous nodules that are found in the pectoral fins.

Vertical fins and their skeleton (*Plate 10*).—The vertical fins include the dorsal, anal, and caudal fins. They are connected to the skeleton by bones placed loosely in the flesh, which have merely slight fibrous attachments to the nearest skeletal parts, or none at all.

The dorsal rays (Plate 10, *78*) are supported by a series of fourteen such free bones which are known as interneurals (Plate 10, *77*), being situated at the interspaces between the neural spines. The 1st interneural of the dorsal fin is situated between the 14th and 15th neural spines. It is very much enlarged. Attached to it are the first four or five dorsal rays which are so closely placed one after the other that they seem to form externally a single big ray. The remaining interneurals gradually decrease in length posteriorly, the tips of the last six or seven no longer reaching those of the nearest neural spines. The articulations between the interneurals and the dorsal rays are by means of cartilaginous nodules, the same as those in the pectoral and ventral fins, and are typical for all the fins, both paired and vertical (Plate 10, fig. F).

Not all the interneurals, however, are concerned with the support of the dorsal fin. The first thirteen interneurals, which are placed loosely in the first thirteen interspaces between the neural spines of each of the corresponding first fourteen vertebræ, are entirely free and not in the least connected to other parts of the skeletal system.

The anal fin is likewise supported and loosely connected to the skeleton by seven or eight such free bones known as interhæmals (Plate 10, *79*) because they are situated in the interspaces between the hæmal spines. At the level of the hæmal spine of the 31st vertebra the quill-shaped and much enlarged 1st interhæmal articulates by fibrous connections with the anterior face of this hæmal spine. Sometimes the next interhæmal is totally ankylosed to the first, except for the basal portion which stays clearly distinct. The next two slender interhæmals, which are very close together, are likewise attached with fibrous connections to the posterior face of this same hæmal spine. The next two also, very close together, are closely applied to the posterior face of the succeeding hæmal spine. The next two are situated in the interspace between the hæmal spines of the 33d and 34th vertebræ, while the last, a very short bone, is exactly at the tip of the hæmal spine of the 34th vertebra. The eleven cartilaginous anal rays (Plate 10, *80*) are articulated with the interhæmals in the same way as in the dorsal fin. The 1st interhæmal is modified to receive the posterior end of the air bladder. The last three or four pairs of movable ribs, the first three interhæmals, and the hæmal spine of the 31st vertebra, all aid in the support of the posterior portion of the air bladder.

The skeletal support for the caudal fin has already been discussed, except for the actual articulation between the caudal rays and these bony skeletal parts (Plate 10, figs. D and E). There are from thirty-six to forty caudal rays (*82*), the dorsal and ventral lobes possessing equally eighteen to twenty rays each. The rays are articulated to the hypurals, and the neural and hæmal spines of the last few vertebræ, by thick cartilaginous pads which form a strong cementing substance between the fin rays and the bones. The cartilaginous rays grasp the bony supports between their diverging bases, these bony supports being inserted deepest in the seven or eight longest rays of each lobe.

INTERMUSCULAR BONES

Situated in the myocommata of both the epaxial and hypaxial muscles are fine tendon bones, known as intermuscular bones (Plates 8 and 9, *76*). They are very much branched in the anterior regions where the muscles are thickest, and gradually decrease in their branchings posteriorly, until in the tail region they are single bones. They do not connect with any part of the skeleton except perhaps through the fibrous myosepia where they are situated. They are responsible for the extremely bony nature of the species.

Epaxial intermuscular bones (Plate 8).—There are from forty-three to forty-five epaxial intermuscular bones on each side, corresponding to the same number of myocommata. The 1st is usually much smaller than the rest, but possesses the most filamentous branches. Sometimes it possesses as many as ten branches at each end. The number of branches gradually decreases posteriorly, until the 30th or 31st myocomma, where the bones are unbranched. The last six or seven do not follow a backward and upward course but are roughly parallel to the long axis of the body corresponding to the position of the muscle masses in this region. The number of these bones may slightly vary on the two sides, but no undue significance need be attached to this variation.

Hypaxial intermuscular bones (Plate 9, figs. A and B).—In the myocommata of the hypaxial muscles intermuscular bones are likewise found. There are from twenty-two to thirty such bones on each side. These bones are not as branched as those in the epaxial region. The first one to four intermuscular bones are very delicate, fine, and unbranched, requiring a great deal of care in dissecting them out. The next eight to twelve possess two branches at their distal ends; the rest are unbranched. As in the dorsal region, the number may slightly vary on the two sides, as also the number of branched and unbranched bones. Similarly, no undue significance need be attached to this difference.

TABLE 1.—*Summary of parts in the skeleton of Chanos chanos (Forskål).*

Region.	Structure.	Total number, both sides.
Skull and visceral skeleton	Vomer	1
	Ethmoid	1
	Prefrontal	2
	Frontal	2
	Sphenotic	2
	Parietal	2
	Epiotic	2
	Supraoccipital	1
	Pterotic	2
	Opisthotic	2
	Exoccipital	2
	Basioccipital	1

TABLE 1.—*Summary of parts in the skeleton of Chanos chanos (Forskål)*—Continued.

Region.	Structure.	Total number, both sides.
Skull and visceral skeleton	Parasphenoid	1
	Alisphenoid	2
	Prootic	2
	Hyomandibular	2
	Symplectic	2
	Quadrate	2
	Pterygoid	2
	Palatine	2
	Mesopterygoid	2
	Metapterygoid	2
	Preopercle	2
	Opercle	2
	Subopercle	2
	Interopercle	2
	Articular	2
	Sesamoid articular	2
	Angular	2
	Dentary	2
	Maxillary	2
	Premaxillary	2
	Interhyal	2
	Epihyal	2
	Ceratohyal	2
	Hypohyals	4
	Glossohyal	1
	Urohyal	1
	Branchiostegals	8
	Basibranchials	3
	Hypobranchials	6
	Ceratobranchials	10
	Epibranchials	8
	Pharyngobranchials	6
	Suspensory cartilage	1
	Supraorbitals	4
	Preorbital	2
	Suborbitals	6
	Postorbital	2
	Nasal	2
	Subtemporal	2
Girdles and fins (paired and vertical fins and their skeletal supports)	Supratemporal	2
	Posttemporal	2
	Supraclavicle	2
	Clavicle	2
	Postclavicle	2
	Hypercoracoid	2
	Hypocoracoid	2

TABLE 1.—*Summary of parts in the skeleton of Chanos chanos (Forskål)*—Continued.

Region.	Structure.	Total number, both sides
Girdles and fins (paired and vertical fins and their skeletal supports)	Mesocoracoid	2
	Actinosts	8–10
	Pelvic girdle	2
	Pectoral rays	30–34
	Ventral rays	20
	Dorsal rays	15–16
	Anal rays	10–11
	Caudal rays	36–40
	Interneurals	27
	Interhæmals	8
	Hypural	6
Vertebral column and ribs	Vertebræ	43–44
	Ribs	56–56
	Epipleurals	46–52
Intermuscular bones	Epaxial intermusculars	86–90
	Hypaxial intermusculars	44–60
	Epipleurointermusculars	4
Possible total		590–619

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1. Vomer
2. Ethmoid
3. Prefrontal
4. Frontal
5. Sphenotic
6. Parietal
7. Epiotic
8. Supraoccipital
9. Pterotic
10. Opisthotic
11. Exoccipital
12. Basioccipital
13. Parasphenoid
14. Alisphenoid
15. Prootic
16. Hyomandibular
17. Symplectic
18. Quadrate
19. Pterygoid
20. Palatine
21. Mesopterygoid
22. Metapterygoid
23. Preopercle
24. Opercle
25. Subopercle
26. Interopercle
27. Articular
28. Sesamoid articular
29. Angular
30. Dentary
31. Maxillary
32. Premaxillary
33. Interhyal
34. Epihyal
35. Ceratohyal
36. Hypohyals
37. Glossohyal
38. Urohyal
39. Branchiostegals
40. Basibranchials
41. Hypobranchials
42. Ceratobranchials
43. Epibranchials
44. Pharyngobranchials
45. Suspensory cartilage
46. Epipleurointermuscular bone
47. Supraorbitals
48. Preorbital
49. Suborbitals
50. Postorbital
51. Nasal
52. Supratemporal
53. Subtemporal
54. Posttemporal
55. Supraclavicle
56. Clavicle
57. Postclavicle
58. Hypercoracoid

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59. Hypocoracoid
60. Mesocoracoid
61. Actinosts
62. Pectoral rays
63. Pelvic girdle
64. Ventral rays
65. Abdominal vertebræ
66. Caudal vertebræ
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69. Neural spine
70. Hæmapophyses
71. Hæmal spine
72. Zygapophyses
73. Parapophyses
74. Rib
75. Epipleurals
76. Intermuscular bones
77. Interneurals
78. Dorsal rays
79. Interhæmals
80. Anal rays
81. Hypural
82. Caudal rays

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ILLUSTRATIONS

[Photographs from actual specimens by Angbengco and Panlilio; text fig. 1 is a drawing from actual specimen by N. Dimanlig, Jr.]

PLATE 1. SKULL, × 1

FIG. A. Dorsal aspect.

B. Ventral aspect.

C. Left lateral aspect.

1, Vomer; *2*, ethmoid; *3*, prefrontal; *4*, frontal; *5*, sphenotic; *6*, parietal; *7*, epiotic; *8*, supraoccipital; *9*, pterotic; *10*, opisthotic; *11*, exoccipital; *12*, basioccipital; *13*, parasphenoid; *14*, alisphenoid; *15*, prootic; *sup cr*, supraoccipital crest or spine; *br art*, articulating surface for branchial apparatus; *hyo art*, articulating surface for head of hyomandibular.

PLATE 2. SKULL, × 1

FIG. A. Posterior aspect. *6*, Parietal; *7*, epiotic; *8*, supraoccipital; *9*, pterotic; *10*, opisthotic; *11*, exoccipital; *13*, parasphenoid; *for mag*, foramen magnum; *art*, facets for articulation of half centrum. (The half centrum was detached to show the basioccipital).

B. Hyoid arch with attached branchiostegals, superior aspect.

C. Same structure, inferior aspect.

33, Interhyal; *34*, epihyal; *35*, ceratohyal; *36*, hypophyals; *37*, glossohyal; *38*, urohyal; *39*, branchiostegals.

PLATE 3

Circumorbital series, left side, outer aspect; × 0.7. *47*, Supraorbitals; *48*, preorbital; *49*, suborbitals; *50*, postorbital; *51*, nasal.

Maxillary series, left side, outer aspect; × 0.7. *31*, Maxillary; *32*, premaxillary.

Mandibular series, left side, outer aspect; × 0.7. *27*, Articular; *29*, angular; *30*, dentary.

Hyopalatine series, left side, outer aspect; × 0.7. *16*, Hyomandibular; *17*, symplectic; *18*, quadrate; *19*, pterygoid; *20*, palatine; *21*, mesopterygoid; *22*, metapterygoid.

Opercular series, left side, outer aspect; × 0.7. *23*, Preopercle; *24*, opercle; *25*, subopercle; *26*, interopercle; *39*, branchiostegals.

Temporal series, left side, outer aspect; × 0.7. *52*, Supratemporal; *53*, subtemporal; *54*, posttemporal.

Pectoral girdle and rays, left side, outer aspect; × 0.7. *55*, Supraclavicle; *56*, clavicle; *57*, postclavicle; *58*, hypercoracoid; *59*, hypocoracoid; *61*, actinosts; *62*, pectoral rays.

Pelvic girdle and rays, left side, outer aspect; × 0.7. *63*, pelvic girdle; *64*, ventral rays.

PLATE 4

FIG. A. Mandibular and hyopalatine series, left side, inner aspect; × 0.7. *16*, Hyomandibular; *17*, symplectic; *18*, quadrate; *19*, pterygoid; *20*, palatine; *21*, mesopterygoid; *22*, metapterygoid; *27*, articular; *28*, sesamoid articular; *29*, angular; *30*, dentary.

B. Pectoral girdle and rays (some parts of temporal series included), left side, inner aspect; × 0.7. *53*, Supratemporal; *54*, posttemporal; *55*, supraclavicle; *56*, clavicle; *57*, postclavicle; *58*, hypercoracoid; *59*, hypocoracoid; *60*, mesocoracoid; *61*, actinosts; *62*, pectoral rays.

C. Pelvic girdle and rays, left side, inner aspect; × 0.7. *63*, Pelvic girdle; *64*, ventral rays.

D. Disarticulated bones of pectoral and pelvic girdles; × 0.6. *53*, Supratemporal; *54*, posttemporal; *55*, supraclavicle; *56*, clavicle; *57*, postclavicle; *58*, hypercoracoid; *59*, hypocoracoid; *60*, mesocoracoid; *63*, pelvic girdle.

PLATE 5. HYOBRANCHIAL APPARATUS. × 1

FIG. A. Superior aspect.

B. Inferior aspect, with hyoid arch extended forward. *33*, Interhyal; *34*, epiphyal; *35*, ceratohyal; *36*, hypophyals; *37*, glossohyal; *38*, urohyal; 40_1, 1st basibranchial; 40_2, 2d basibranchial; 40_3, 3d basibranchial; 41_1, 1st hypobranchial; 41_2, 2d hypobranchial; 41_3, 3d hypobranchial; 42_1, 1st ceratobranchial; 42_4, 4th ceratobranchial; 42_5, 5th ceratobranchial; 43_1, 1st epibranchial; 43_4, 4th epibranchial; 44_1, 1st pharyngobranchial; 44_3, 3d pharyngobranchial; *45*, suspensory cartilage; *a*, bony portion of glossohyal; *car*, cartilage; *m*, membrane.

PLATE 6

FIG. A. *65*, Abdominal vertebræ; *66*, caudal vertebræ; *74*, ribs; *81*, hypurals; *82*, caudal rays; *a*, atlas; *b*, axis.

B. Complete skeleton from the right side. Intermusculars of right side held in place by fine wires which can be seen on close scrutiny; × 0.2.

PLATE 7

Figures 0.6 actual size.

FIG. A. Atlas, left lateral aspect.

B. Axis, left lateral aspect.

C. Third vertebra and ribs, anterior aspect.

D. Seventeenth vertebra; last abdominal vertebra, anterior aspect.

E. Eighteenth vertebra; 1st caudal vertebra, anterior aspect.

F. Thirty-second vertebra; a typical caudal vertebra, anterior aspect.

G. Thirty-first vertebra; 1st caudal vertebra without ribs, left lateral aspect.

H. Eleventh vertebra; disarticulated to show parts of typical abdominal vertebra, anterior aspect.

67, Centrum; *68*, neurapophyses; *69*, neural spine; *70*, hæmapophyses; *71*, hæmal spine; *72*, zygapophyses; *73*, parapophyses; *74*, rib; *75*, epipleural.

PLATE 8

Figures 0.5 actual size.

FIG. A. Epaxial intermuscular bones of left side.

B. Epaxial intermuscular bones of right side.

76, Intermuscular bones. *a*, First intermuscular bone; *b*, last intermuscular bone.

PLATE 9

Figures 0.5 actual size.

FIG. A. Hypaxial intermuscular bones of left side.

B. Hypaxial intermuscular bones of right side.

76, Intermuscular bones; *a*, first intermuscular bone; a_n, last intermuscular bone.

C. Epipleurals of left side.

D. Epipleurals of right side.

46, *a*, *b*, Epipleurointermuscular bones; *c*, first real epipleural; *d*, last epipleural.

PLATE 10

FIG. A. Free interneurals; × 0.5. *77*, Interneural; *a*, first interneural; *b*, last interneural.

B. Dorsal fin and skeleton, left lateral aspect; × 0.5. *77*, Interneural; *78*, dorsal rays; *a*, first interneural of fin; *b*, last interneural of fin.

C. Anal fin and skeleton, left lateral aspect; × 0.5. *79*, Interhæmal; *80*, anal rays; *a*, modified 1st interhæmal; *b*, last interhæmal.

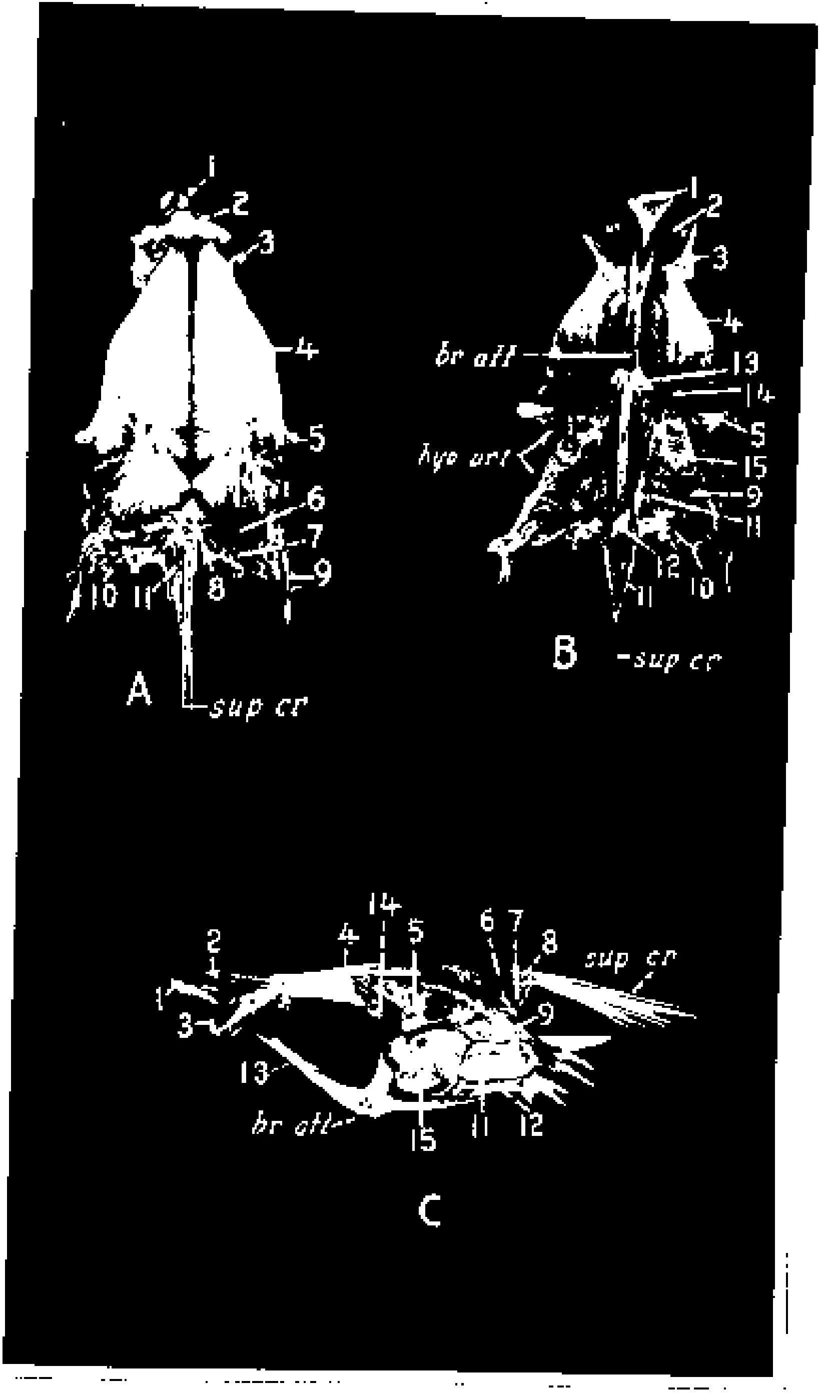
D. Detailed structure of caudal region; × 0.7. *66*, Caudal vertebræ 42d and 43d; *81*, hypurals.

E. Caudal region showing tail attachment; × 0.7. *82*, Caudal rays.

F. Structure of a typical fin skeleton (2d dorsal fin skeleton); × 0.06. *77*, Interneural; *78*, dorsal ray; *car*, cartilaginous nodule.

TEXT FIGURE

FIG. 1. Skull, left lateral aspect; × 1.5. *4*, Frontal; *16*, hyomandibular; *21*, mesopterygoid; *22*, metapterygoid; *23*, preopercle; *24*, opercle; *25*, subopercle; *26*, interopercle; *27*, articular; *29*, angular; *30*, dentary; *31*, maxillary; *32*, premaxillary; *39*, branchiostegal; *47*, supraorbitals; *48*, preorbital; *49*, suborbitals; *50*, postorbital; *51*, nasal; *52*, supratemporal; *53*, subtemporal; *sup cr*, supraoccipital crest or spine.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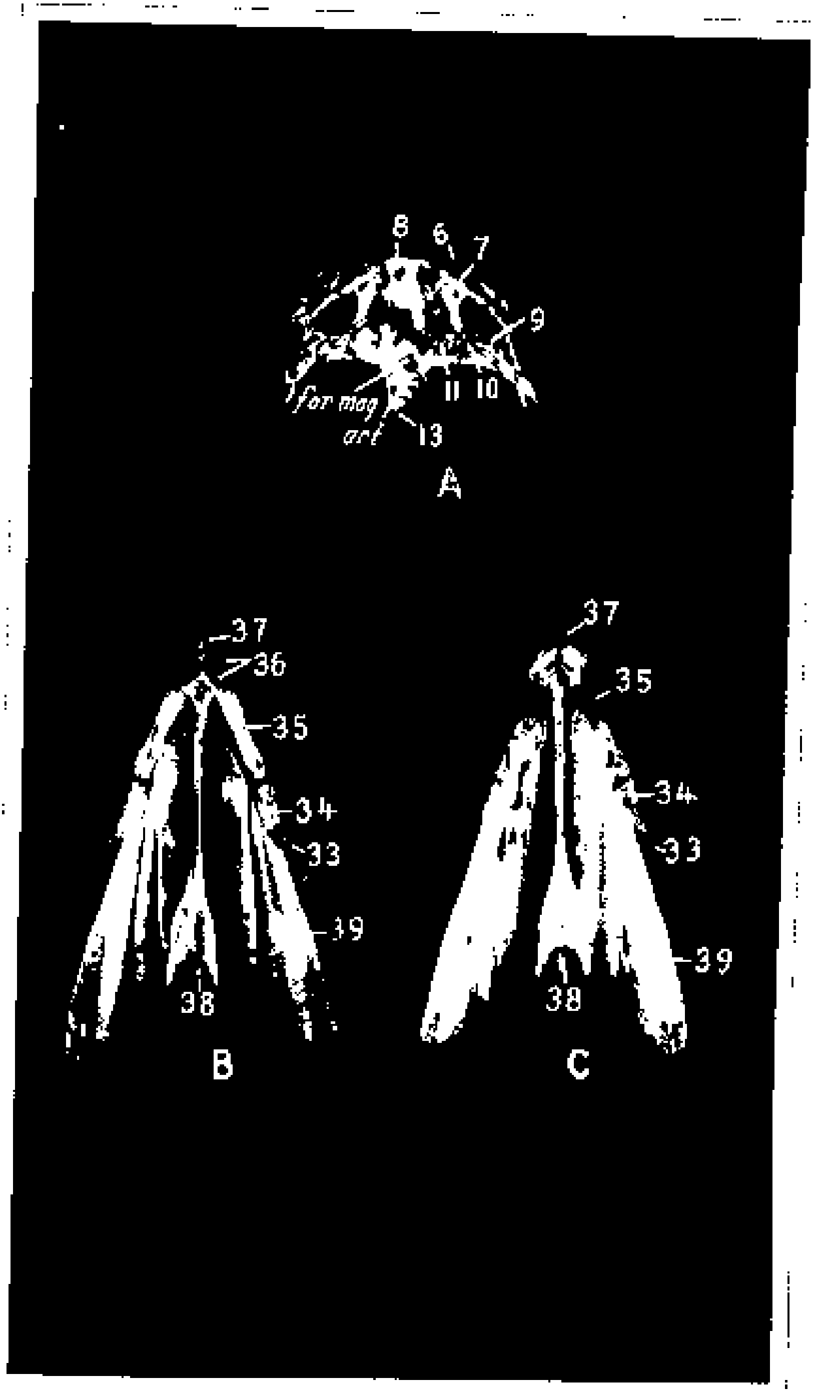

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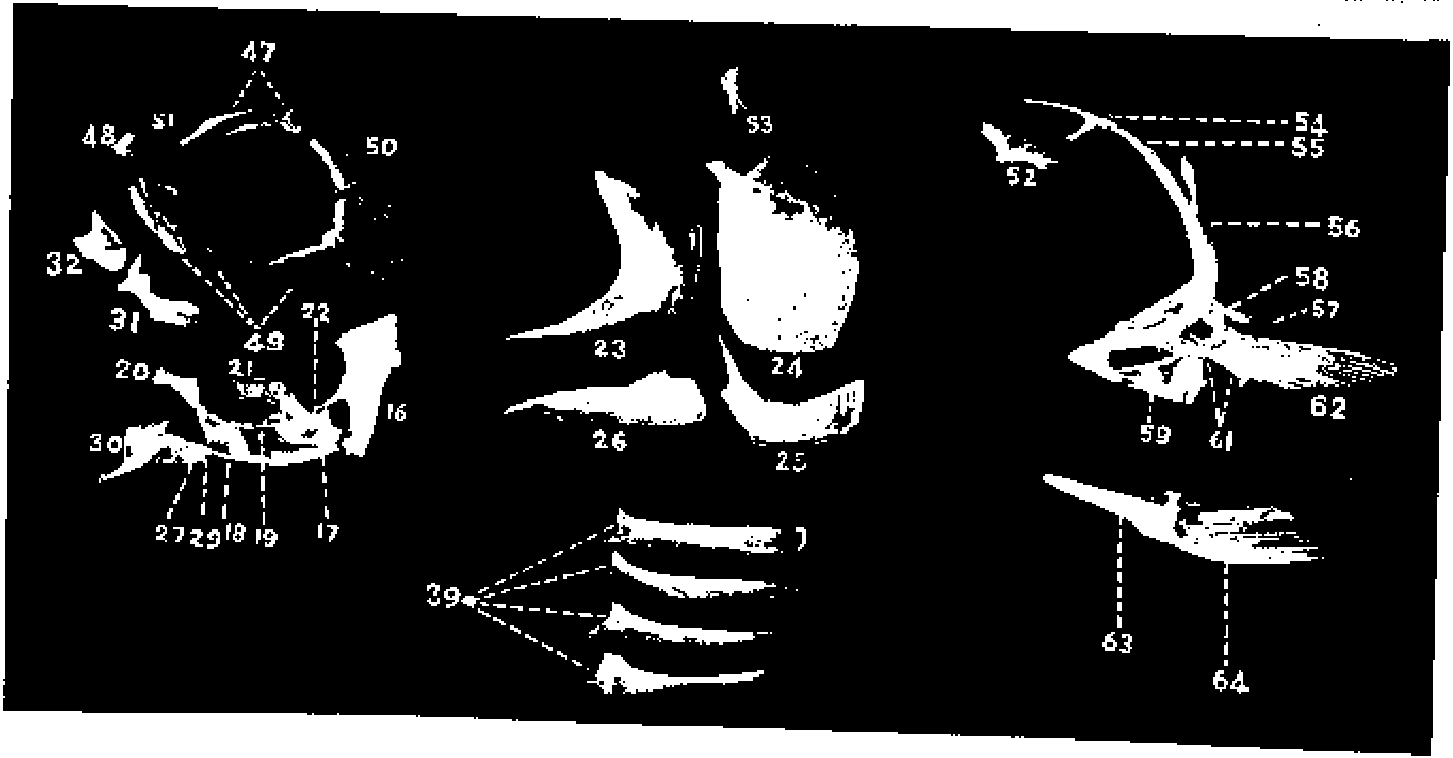
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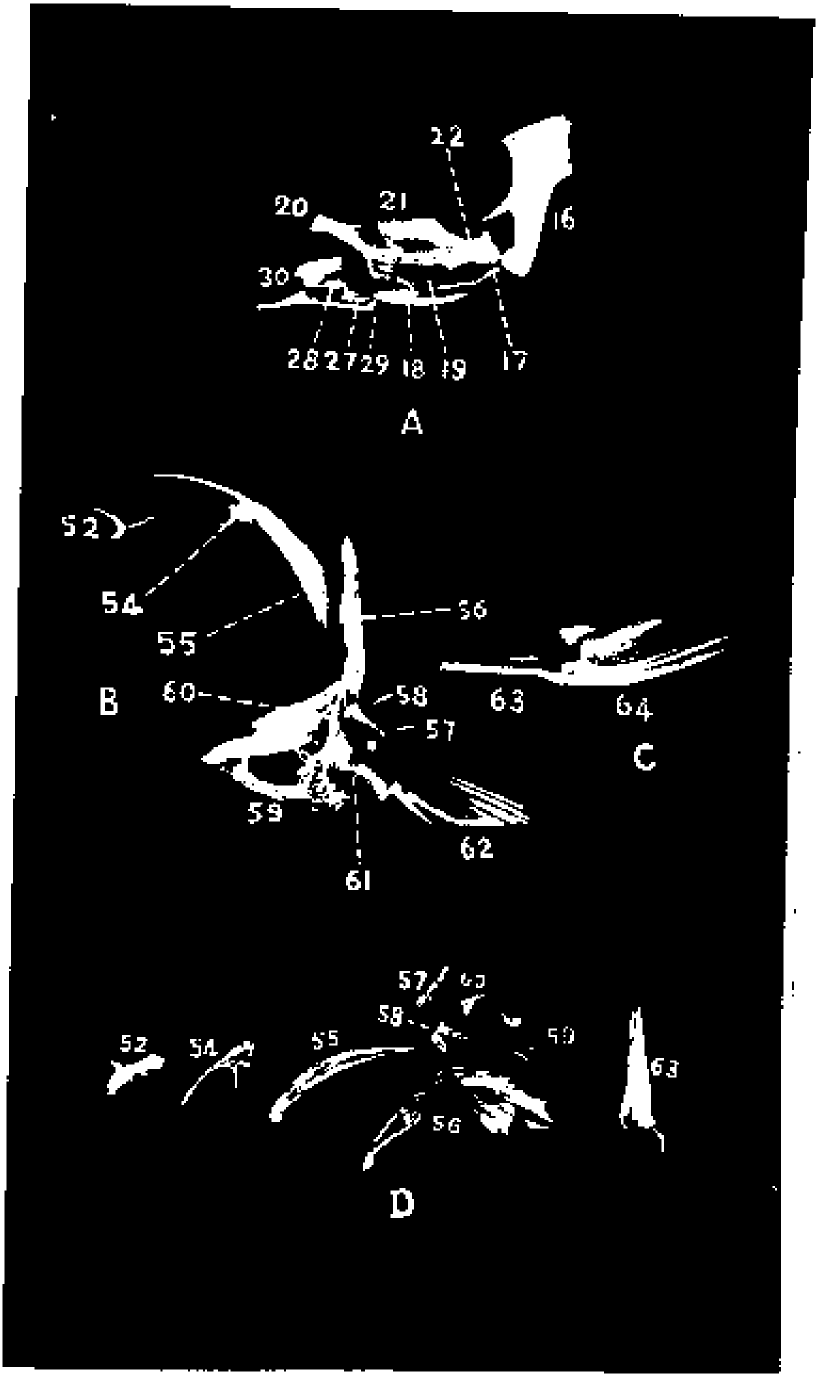
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PLATE 4.

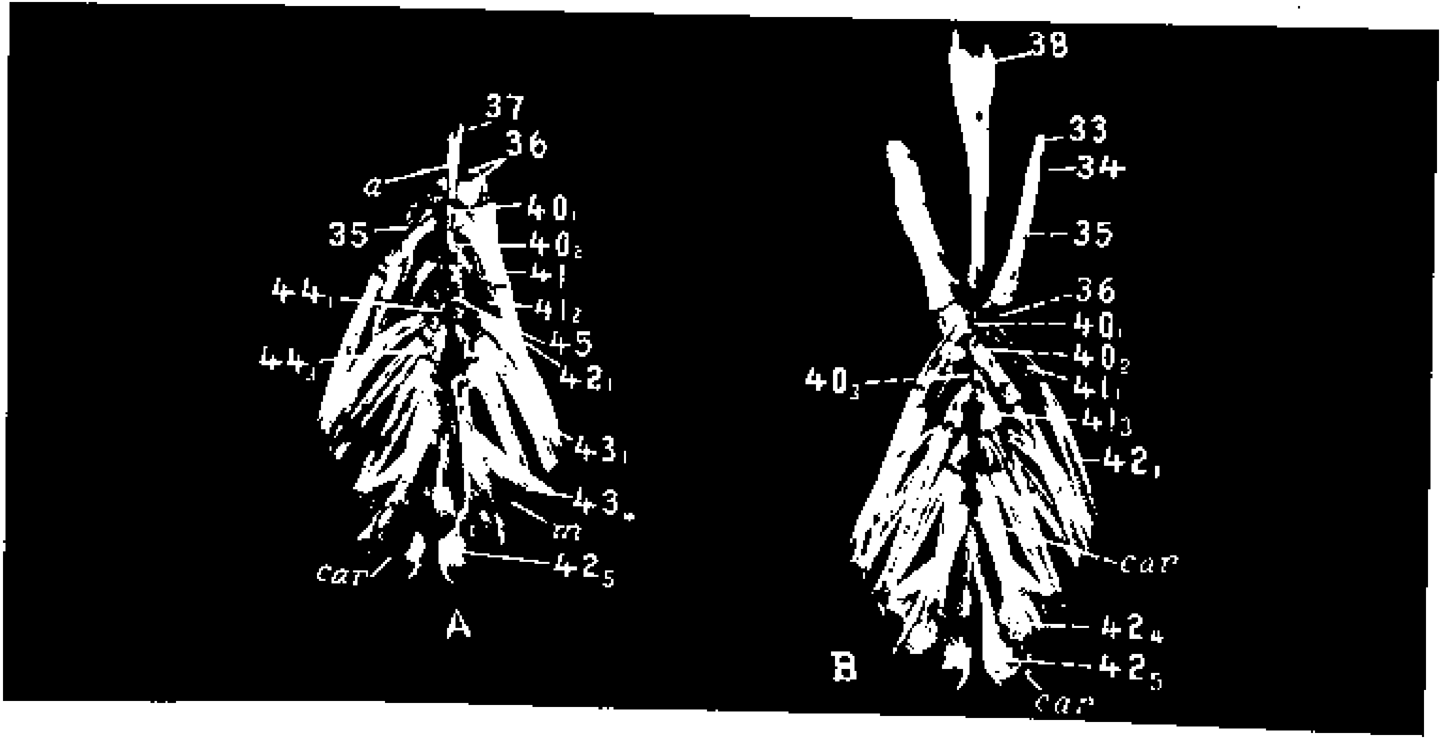
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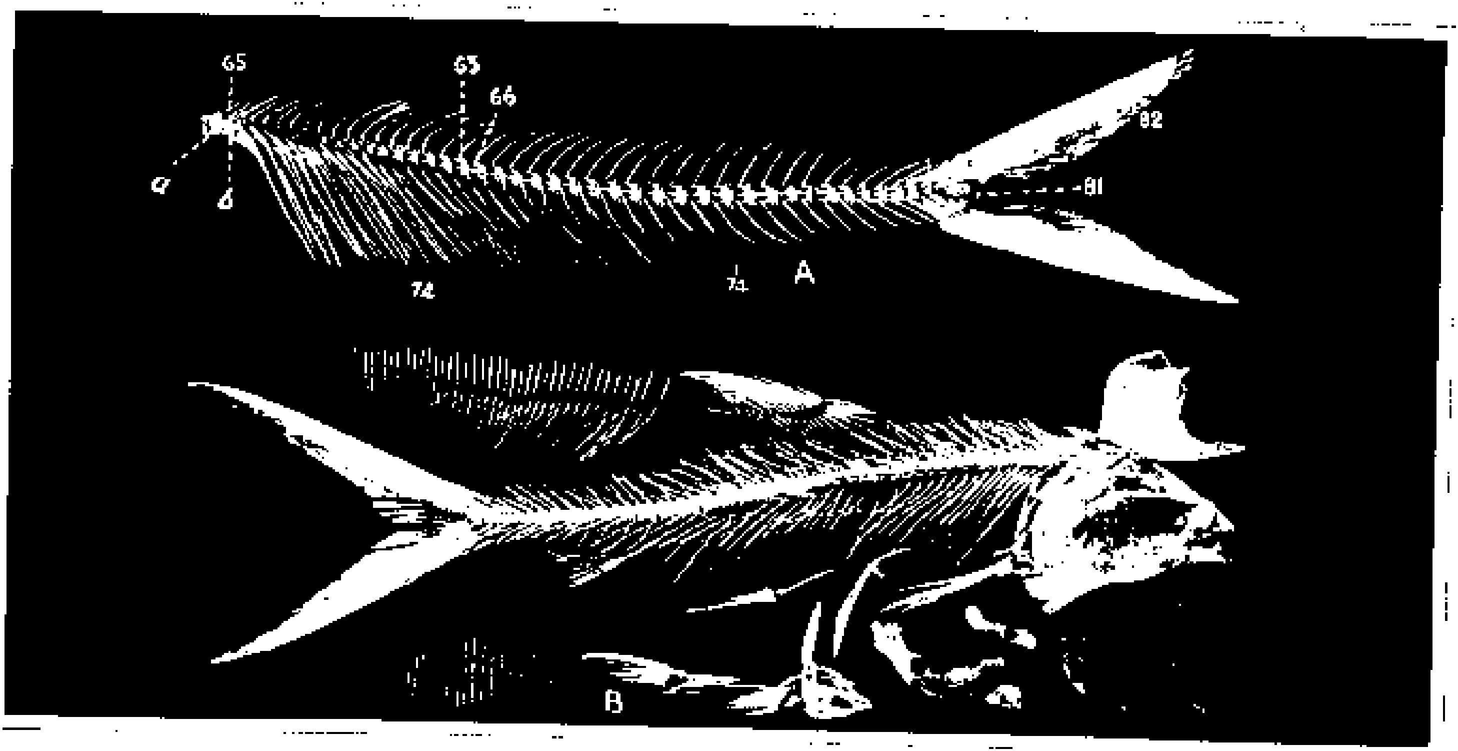
PLATE 7.



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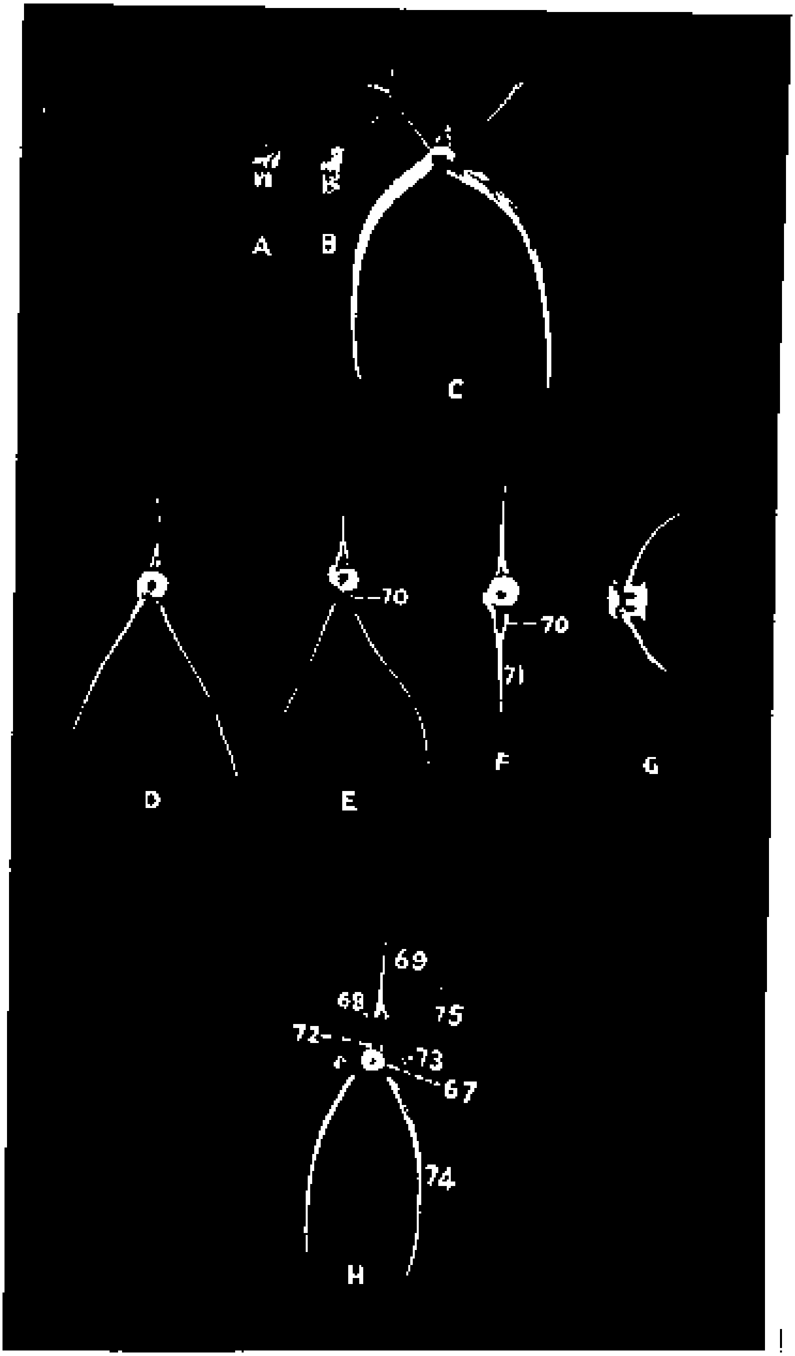
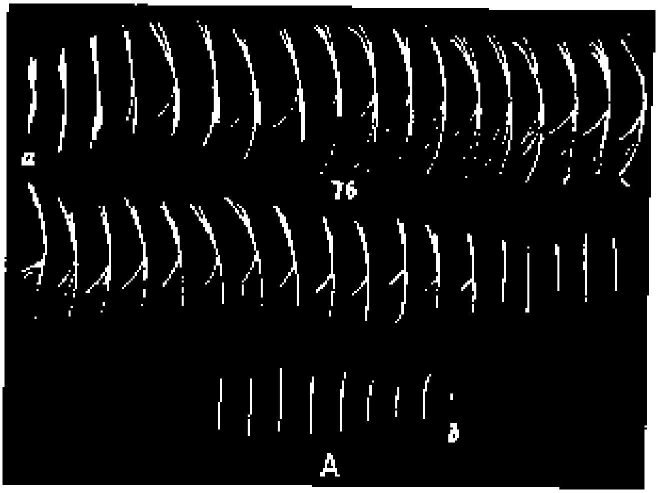


PLATE 7.



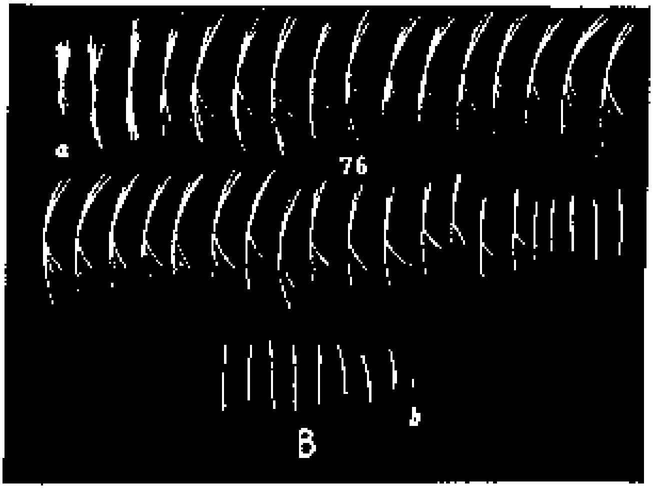


PLATE 8.

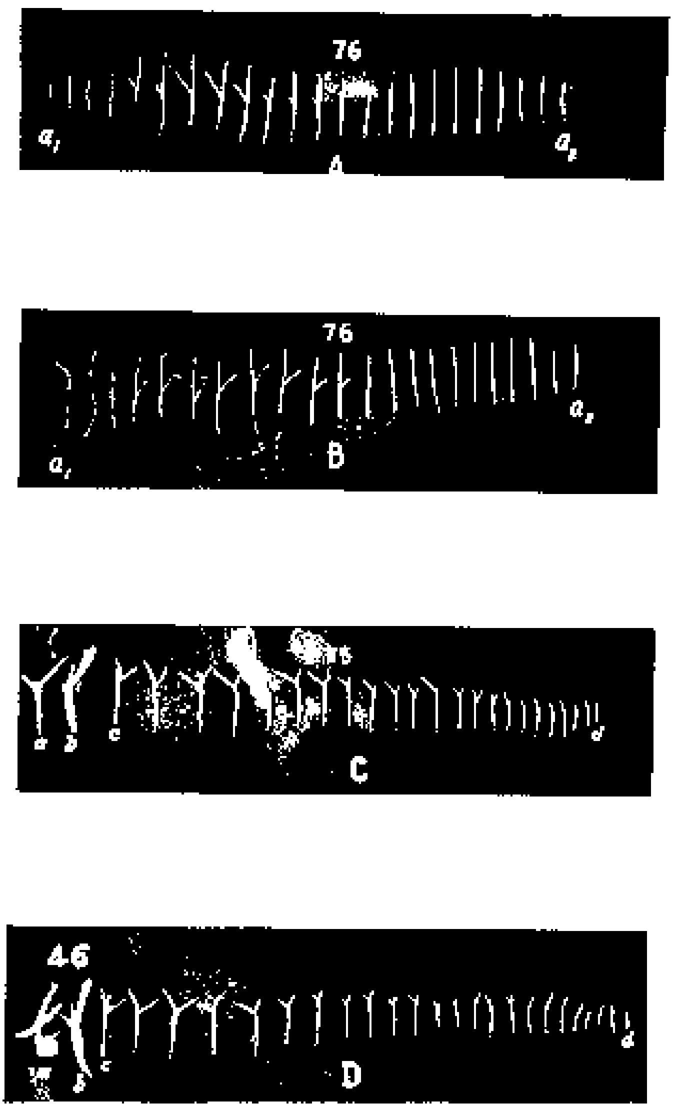


PLATE 9.

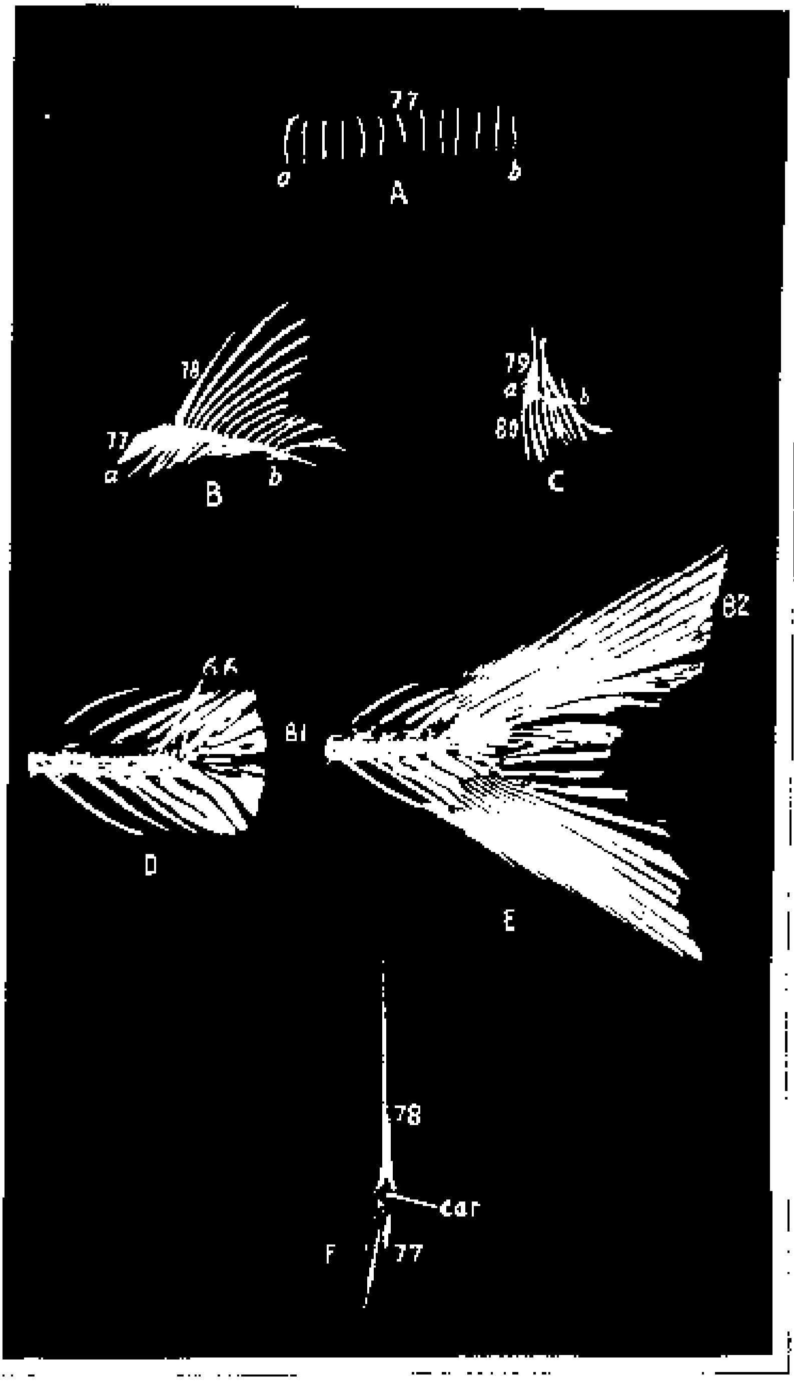


PLATE 10.

EARLY LIFE HISTORY OF THE VIVIPAROUS PERCH TÆNIOTOCA LATERALIS AGASSIZ [1]

By GUILLERMO J. BLANCO

Of the Fish and Game Administration, Bureau of Science, Manila

FIVE PLATES

This paper presents a study of the early development of the viviparous blue perch, *Tæniotoca lateralis*, family Embiotocidæ, covering the morphological structure of the ovary and the larval development of the young.

The material on which this study is based consists of mature specimens with various stages of ovaries of *Tæniotoca lateralis*, collected in Puget Sound, Washington, from 1929 to 1932, by the faculty and students of the Department of Fisheries, University of Washington.

An adult female of *Tæniotoca lateralis* was dissected to determine the position of the ovary in the body cavity. Other dissections were made to study the morphological structure of the ovary.

Female specimens of *T. lateralis* caught in September, October, and November, 1932, were found to contain eggs in various cleavage stages, and from December, 1932, to July, 1933, various stages of the larvæ and young were also found.

The eggs were removed from the ovarian sacs, washed in water to remove formalin, passed through various concentrations of alcohol up to 100 per cent, cleared with Beechwood creosote, and then placed in concave glass slides for examination.

The ordinary methods of killing, staining, and clearing the tissues and embryos were used.

The cross sections of an ovary fixed with formalin were prepared by the paraffin method, stained with hæmatoxylin and eosin, and cleared with xylene.

The larvæ preserved in formalin were washed with water, stained with borax carmine overnight, destained with 70 per cent acid alcohol, cleared with Beechwood creosote, and then mounted on glass slides.

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[1] A portion of a thesis presented for the degree of Master of Science (Fisheries) in 1933, prepared under the direction of Dr. Leonard P. Schultz, formerly with the University of Washington, Department of Fisheries.

The eggs were measured with a filar micrometer eyepiece and the data recorded.

All drawings were made with the aid of a camera lucida and projection drawing apparatus at known magnifications.

The writer wishes to express his thanks to Dr. Leonard P. Schultz, formerly with the Department of Fisheries, University of Washington, for furnishing part of the material and for his kind suggestions and helpful criticism.

HABITS OF TÆNIOTOCA LATERALIS

Tæniotoca lateralis Agassiz is found from Vancouver Islands to San Diego, rarely southward (Eigenmann and Ulrey, 1894) from the latter point.

The secondary sexual characters of the male and female *Tæniotoca lateralis* are similar to those found in *Cymatogaster aggregatus*, *Damalichthys vaca*, and the related species *Amphigonopterus aurora*, of the family Embiotocidæ. The anal fin in the female is unmodified, and the anal fin of the male has on each side a glandlike structure with a free duct pointing forward. The males of *Amphigonopterus aurora*, *Cymatogaster aggregatus*, and *Micrometrus minimus*, have well-developed glands and testes soon after birth, but Hubbs (1921) found that one-year-old males of *Embiotoca lateralis* (=*Tæniotoca lateralis*) were immature.

The breeding habits of the blue perch are not definitely known. Probably all the viviparous perches inhabiting the shores along the entire coast from San Diego to Puget Sound have more or less similar breeding habits, with a slight variation in the time of breeding during the summer (Hubbs, 1917, 1921).

The breeding habits of *Cymatogaster aggregatus* were observed by Hubbs (1917) July 5, 1916, in a shallow channel of an estuary in Santa Barbara County, California. His description, quoted below, serves as an example of the process of copulation in the viviparous perches.

> Attention was first directed to a slight disturbance about twenty feet offshore, where two "Shiners" were swimming with their backs just out of the water. Very soon the pair were joined by six others, which judging from their small size, were likely males. The original pair swam slowly towards shore, their caudal regions in close proximity. The largest of the supernumerary fishes immediately preceded the pair, while the others followed a short distance behind. Occasionally the male turned partly

> unto his side. After the fishes had proceeded thus shoreward about six feet, there ensued a commotion, of which the details were not observed, and then all but the first pair swiftly made for deeper water offshore.
>
> The pair, now alone, then proceeded against the tide in a semi-circular course of about five feet, frequently pausing while the male, turning upon his side, applied his anal region to that of his mate. Finally reaching the shelter of a stone in about a foot of water, the pair halted and copulation ensued. With their heads in the same direction and their anal regions in contact the pair remained quite motionless for a few seconds, seeming to balance in the water. The male turned over to a nearly horizontal position, the female much less. For several seconds the male moved rather slowly about half an inch back and forth, paused, then resumed the vibratory movement for a few seconds and finally darted off without warning into deeper water.

James Blake's suggestion that the ventral surfaces are appressed, the heads of the fish pointing in opposite directions during copulation, is contrary to the observations of Hubbs (1916).

The time of breeding of *Tæniotoca lateralis* can be determined from a study of the eggs and larval stages. Eigenmann (1904) stated that copulation of *Cymatogaster* takes place during June or the early part of July, but the eggs are not fertilized until the following December. He based his conclusion on the seasonal behavior of the males and females, the stages of development of the testes in the males, and the presence of spermatozoa in the ovarian follicles in summer and late fall. Hubbs (1917) verified the evidence of his first observations on the copulation of *Cymatogaster* and added that delayed fertilization of the eggs probably happens in all of the viviparous perches.

In *Tæniotoca lateralis* ovaries of the materials of 1933 examined in October and November showed that the eggs were in late cleavage, blastula, gastrula, and embryonic stages. In December there were minute larvæ 1 mm long. The successive larval stages from December, 1932, to July, 1933, measure from 1 mm to 51 mm in total length.

Since the larvæ remain in the ovary from October to June and July, it is thought that the period of copulation of the blue perch probably is from June to August. The spermatozoa are retained in the ovary of the females until fertilization takes place in September.

STRUCTURE OF THE OVARY

The normal position of the ovary in the body cavity of a *Tæniotoca lateralis* 11.5 inches long and 5.2 inches deep is shown in Plate 1, fig. 1. The ovary, 13 mm long, is suspended from the dorsal wall of the abdomen by a mesovarium on its anterior portion and by a mesorectum on its posterior portion.

The ovary is a spindle-shaped bag in its early stages of development, from October to June, and in July becomes oblong as the developing embryos within increase in size (Plate 1, figs. 2 to 9). The anterior part of the ovary is divided into two arms or horns, indicating that the ovary has a bilateral origin. The left arm of the ovary, like the left arm of the ovary of *Cymatogaster aggregatus*, is usually much smaller than the right arm; the blood vessel entering the shorter left arm is likewise smaller. There are some cases where the two arms of the ovary are symmetrical. The ovaries of the sides have been united on the posterior region above the rectum, so that only the left and right anterior arms show the bilateral external structure.

Plate 2, figs. 10 and 11, show the structure of the ovarian sacs and their compartments. Two sacs are suspended from the inner upper margin of the ovarian wall. A cross section through the ovary at an early stage in October shows definitely how portions of the ovarian sacs come in contact with the inner upper margin of the ovarian wall, and the manner of arrangement of the compartments of the ovarian sacs (Plate 2, fig. 12). The sacs have their open ends at the posterior end of the bag. The left sac has a single vertical partition, thus being divided into two compartments c_1 and c_2, while the right sac of the ovary has two vertical partitions making three compartments, c_3, c_4, and c_5. The two ovarian sacs of *Tæniotoca lateralis* have usually five compartments compared with the four compartments of the ovarian sacs of *Cymatogaster aggregatus*. There are, however, exceptions to the five-compartment arrangement in *Tæniotoca lateralis*.

The ovarian sacs and their vertical partitions are highly vascular. A great number of blood vessels (*rbv*) and capillaries radiate from the right and left anterior arms and traverse the ovarian sheets towards their open ends.

The histological structure of the ovarian walls and the ovarian sheets of *Cymatogaster aggregatus* has been described by Eigenmann (1894). Since there is a very distinct similarity of the morphological structure of the ovaries of *Cymatogaster aggregatus*, *Tæniotoca lateralis*, and other related species of the family Embiotocidæ, it is probable that the histological structure of the ovarian wall and ovarian folds are also identical in all the related species in this family. The following quotation describes the histological structure of the ovarian wall and ovarian folds of *Cymatogaster aggregatus*:(6)

> The ovarian walls are composed first of the thin peritoneal membrane; second, of a layer of longitudinal muscle fibers; third, of a layer of circular muscle fibers, inside of which there is in places, another layer of longitudinal fibers; fourth, a very thin layer of cells with flattened, deeply stainable nuclei; fifth, of a layer of epithelium. This layer is derived from the peritoneum. The cavity of the ovary arises as a groove on the lateral portion of the germinal ridge. The raised margins of the groove unite and form the ovarian cavity, which remains for some time connected with the body cavity by a ciliated opening. The inner linings of the ovary are thus of peritoneal origin. Laterally and ventrally the two inner layers form simple thin linings; dorsally they are thrown up into a number of low ridges. Besides these ridges there are on either side of the median dorsal line three broad sheets which are simply ridges enormously exaggerated. These sheets are united to form the sacs mentioned above. Cross-sections of these sheets show them to be composed externally of a continuation of the epithelium lining the ovarian sheath and internally by a continuation of the membranous tissue lying immediately outside the lining epithelium of the ovarian walls. In other words Nos. 4 and 5 of the structures enumerated above are raised and greatly prolonged to form these sheets. Ventrally the three sheets of each side have become united. The inner layers of these sheets sometimes form a solid tissue, but frequently they are well separated or connected by occasional fibers only. The latter is probably an artificial condition.
>
> The blood vessels found in the sheets lie between the two inner layers of cells and are surrounded by tissue derived exclusively from the ovarian walls. They are always quite distinct from the surrounding tissues.

GENERAL DEVELOPMENT OF THE EGGS AND THE LARVÆ IN THE OVARY

Oögenesis takes place in the ovarian sheets, and as soon as maturation is complete, the ova are freed from the ovarian follicles. Cross sections through the ovary in October indicate various stages of maturing eggs. Plate 3, figs. 16 and 17, are cross sections through 1-celled eggs, which were free in the ovarian follicles but not free in the ovarian compartments.

Eigenmann (1894) states that the eggs are freed from the follicles before segmentation begins, and fertilization takes place just before or after they are set free in the ovarian compartments. I was unable to verify this point owing to the lack of material in September and October. Only the postembryonic stages of the eggs were available in November

(Plate 3, figs. 19 to 24). The fertilized eggs and the larvæ are not connected with any part of the ovary during their development.

ARRANGEMENT OF THE LARVÆ IN THE OVARY

Examination of several ovaries containing various stages of larvæ of *Damalichthys vacca* and *Tæniotoca lateralis* indicated that there was no definite arrangement of the larvæ in the ovarian compartments. A similar condition was found in *Cymatogaster*. The embryos were tightly packed against the ovarian walls and ovarian folds, some directed forward and others backwards. Eigenmann (1894) found that when the larvæ had well-developed gills and were about ready to be born, their heads were towards the origin of the oxygenated blood supply at the anterior end of the ovary.

NUMBER OF LARVÆ IN THE OVARY

It is generally known that the larger females of any given species of fish (oviparous or viviparous) are more prolific than the smaller females. Eigenmann (1894) found the number of larvæ in the ovary of *Phanerodon lateralis* (= *Tæniotoca lateralis*) to vary from 21 to 30, the largest number being found in the older females. Hubbs (1921) gave the number of larvæ in different sizes of *Embiotoca lateralis* as follows: First specimen, 257 mm long, contained 26 larvæ 46 to 49 mm long; second specimen, 265 mm long, contained 26 larvæ 50 to 54 mm long; third specimen, 200 mm long, contained 10 larvæ 55 to 58 mm long, but Hubbs suspected that some of the larvæ had been born earlier. My counts of the Puget Sound material ranged from 18 to 92 larvæ, depending on the size of the specimen.

NOURISHMENT AND RESPIRATION OF THE YOUNG

The small amount of the yolk in the small egg, absorbed early during the larval period, is not sufficient for the growth of the embryo and the larva. Eigenmann (1894) states that there is a general surface absorption of ovarian fluid throughout the ovarian life, so that the process of absorption by the general surface supplies the necessary food of the larva until the first gill slit is open. He observed that a continuous stream of ovarian fluid which entered through the first gill slit into the intestinal canal was accounted for by the ciliary movements in the intestinal canal and also by the motility of the tails of the spermatozoa found in the ovary and inner surface of the intestinal tract during early gestation. The hind gut containing long hollow vascular villi found in the embryos of *Tæniotoca lateralis* and in other genera of the family has been described long ago as the region of food absorption at the time of the opening of the mouth of the embryo.

The ovarian fluid described by Eigenmann (1894) and other writers consists of solid cell particles which are derived from the epithelial lining of the ovarian folds.

The embryos and larvæ are always in contact with the ovarian structures which obtain their blood supply directly from the gills. The presence of the highly active spermatozoa in the ovarian fluid and in the intestinal tract of the larva accounts for the distribution of the oxygenated albumen in all parts of the ovary. The highly vascular fins in the later stages are in direct contact with the same highly vascular ovarian folds, thus obtaining their oxygenated albumen (Eigenmann 1894, Hubbs 1921, and Ryder 1885).

DEVELOPMENTAL STAGES

The mature egg within the ovarian follicle (Plate 3, fig. 18) is spherical, having a diameter of about 0.3 mm. It has a distinct thin, vitelline membrane, enclosing unequal-sized oil globules evenly distributed.

The manner of cell division has not been observed for lack of complete series of segmenting eggs.

Plate 3, fig. 19, illustrates an early stage of differentiation of the germ ring. The egg measured 0.69 mm in diameter; blastoderm, 0.47; yolk, 0.36; and yolk nucleus, 0.23.

Plate 3, fig. 20, shows the blastoderm of an egg with fully developed germ ring and the beginning of the embryonic shield. The head of the embryo develops from the posterior pole of the embryonic shield. The diameter of the egg measured 0.67 mm; blastoderm. 0.47; yolk, 0.36; and the yolk nucleus, 0.22.

The embryo is coiled around the yolk (Plate 3, fig. 21). The diameter of the egg is 0.75 mm; the coiled embryo, 0.69; yolk, 0.46; and the yolk nucleus, 0.19.

Plate 3, fig. 22, is a lateral view of an embryo with several somites. The diameter of the egg measured 0.79 mm; the coiled embryo, 0.71; yolk, 0.52; and the nucleus, 0.23.

In the ventral view of an embryo (Plate 3, fig. 23) the diameter of the egg measured 0.79 mm; embryo, 0.61; yolk, 0.39; the yolk nucleus, 0.22.

Plate 3, fig. 24, is an advanced stage of an embryo which has distinct eyes before hatching. The diameter of the embryo measured 0.79 mm; embryo, 0.67; yolk, 0.35; yolk nucleus, 0.22.

The diameters of 22 eggs in October ranged from 0.67 to 0.79 mm, and in November, 27 eggs from 0.79 to 0.81 mm.

The embryo before hatching encircles the yolk; the head region is larger than the caudal region.

A larva 3 mm long (Plate 4, fig. 25) is straight and has 36 segments; it has narrow dorsal and ventral fin folds but its protocercal caudal fin has no trace of the fin fold at its tip. The protruding hind gut is well extended beyond the yolk sac which contains a small amount of yolk material. The heart is a slender tube extending from the dorsal wall of the pericardium. There are four gill slits; the first slit to open was found in a larva 4 mm long, in which the auditory capsule is very distinct in the developing cranium, but the lens of the eye is not well differentiated. The notochord is a straight cartilaginous rod extending from the hind brain to the end of the protocercal caudal fin.

In a larva 7 mm long (Plate 4, fig. 26) the notochord extends to the axial lobe of the caudal; the dorsal fin fold is narrower than the ventral fin fold. The intestine is coiled and has no elongated saclike hind gut containing numerous villi in its inner side. The liver has now occupied the former place of the yolk sac. The chambers of the heart are indistinct. The air bladder is an outgrowth of the dorsal wall of the œsophagus and is located dorsal to the intestine. The coracoscapular cartilages traverse the thoracic region.

In a larva 12 mm long (Plate 4, fig. 27) the maxillaries, eyes, brain, and opercles are well developed. The alimentary tract and circulatory system do not show further development. The dorsal and ventral fin folds posterior to the abdominal region are wider than those of the caudal peduncle. The ventral lobe of the caudal fin is larger than the upper axial lobe.

A larva 16 mm long (Plate 5, fig. 28) has well-developed dorsal and anal fins, but retains traces of the fin folds in the region of the caudal peduncle. The homocercal caudal fin has the beginnings of cartilaginous epurals and hypurals and these are not fused with the chordal axis. The caudal fin has grown larger.

A larva 21 mm long (Plate 5, fig. 29) has enlarged dorsal and anal fins which are highly vascular. The vertebræ are indistinct in toto mounts, and the coracoscapular cartilages still persist. The short intestine runs posteriorly, then curves to the right and runs forward between the lobes of the liver, turning in another curve upwards, then into a short posterior curve to the much enlarged hind gut. The air bladder is dorsal to the liver and intestine in the body cavity.

A larva 41 mm long (Plate 5, fig. 30) has 11 spinous rays and 23 soft rays in the dorsal fin and 3 spinous rays and 30 soft rays in the anal fin The dermotrichia of the caudal fin originate on top of the 3 dorsal caudal radials and hypurals. The pectoral and ventral fins are well developed. The intestine with a much reduced hind gut now lies in the body cavity. The heart has three well-developed chambers, sinus venosus, auricle, and ventricle. The vertebræ, which are very prominent, number between 35 and 37. The lateral line and scales have already appeared, the latter showing a few growth rings around their foci.

The development of the homocercal caudal of *T. lateralis* was previously published in this journal.(2)

SUMMARY

1. *Tæniotoca lateralis* Agassiz is a viviparous perch, found in shallow waters along the entire coast between San Diego, California, and Vancouver Island, Canada.

2. The secondary characters of the male and female *Tæniotoca* are similar to those found in *Cymatogaster;* the male has a glandlike structure on the sides of the anal fin, while the female has a normal anal fin. The males of *Tæniotoca* do not mature until more than one year old.

3. The ovary in the body cavity is spindle-shaped in its early stage, and becomes gradually oblong as the larvæ increase in size. The anterior arms of the ovary are usually unequal, the left being smaller. The ovary has two distinct sacs with five compartments.

4. The maturation of the eggs takes place in the ovarian follicles, and their development starts when they are freed in the ovarian compartments.

5. The eggs and larvæ are not connected with any part of the ovarian structures during their development.

6. The number of larvæ in the ovary ranges between 18 and 92, the larger numbers occurring in the larger fishes. The larvæ have no definite arrangement within the ovary and are able to change their position even when nearing extrusion.

7. The food absorbed and digested by the growing larva consists of the ovarian fluid and solid cell-like particles which are the products of the epithelial lining of the ovarian folds. The ovarian fluid is aërated by circulation within the ovarian follicles. The highly vascular fins in the later larval stages are always in contact with the highly vascular ovarian folds, thus obtaining their oxygenated albumen. The gills are well developed and undoubtedly become functional in later stages of the young while the latter are still in the ovary.

8. The young, when born, possesses nearly all of the adult characters of the parent fish.

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ILLUSTRATIONS

[Abbreviations: *aaos*, anterior arm of ovarian sac; *ab*, air bladder; *au*, auditory capsule; *bc*, body cavity; *br*, branchial gill slit; *bv*, blood vessel; *c1*, *c2*, *c3*, *c4*, *c5*, compartments 1, 2, 3, 4, and 5; *csc*, coracoscapular cartilage; *dos*, division of ovarian sac; *e*, egg; *es*, embryonic shield; *gr*, germ ring; *ht*, heart; *hg*, hind gut; *i*, intestine; *l*, liver; *m*, mesentery; *mo*, mesovarium; *mr*, mesorectum; *n*, nucleus; *o*, ovary; *oc*, ovarian cavity; *of*, ovarian follicle; *og*, oil globule; *op*, ovarian partition; *ow*, ovarian wall; *rbv*, radial blood vessel; *umos*, upper margin of ovarian sac; *v*, villi; *ys*, yolk sac.]

PLATE 1. TÆNIOTOCA LATERALIS AGASSIZ

FIG. 1. Normal position of the ovary in the body cavity.
2. Stage of the ovary, October 22, 1932.
FIGS. 3 and 4. Stages of the ovary, November 14, 1932.
FIG. 5. Stage of the ovary, January, 1932.
6. Stage of the ovary, February 11, 1932.
7. Stage of the ovary, March 8, 1932.
FIGS. 8 and 9. Stages of the ovary, July, 1932.

PLATE 2. TÆNIOTOCA LATERALIS AGASSIZ

FIG. 10. Ovarian compartments of an ovary with arms of equal size, July 1, 1930.
11. Ovary, diagrammatic arrangement of two sacs and five compartments.
12. Cross section through an ovary, October 22, 1932.
13. Cross section through a portion of the inner lining of an ovarian wall.
14. Cross section through the posterior region of an ovary.

PLATE 3. TÆNIOTOCA LATERALIS AGASSIZ

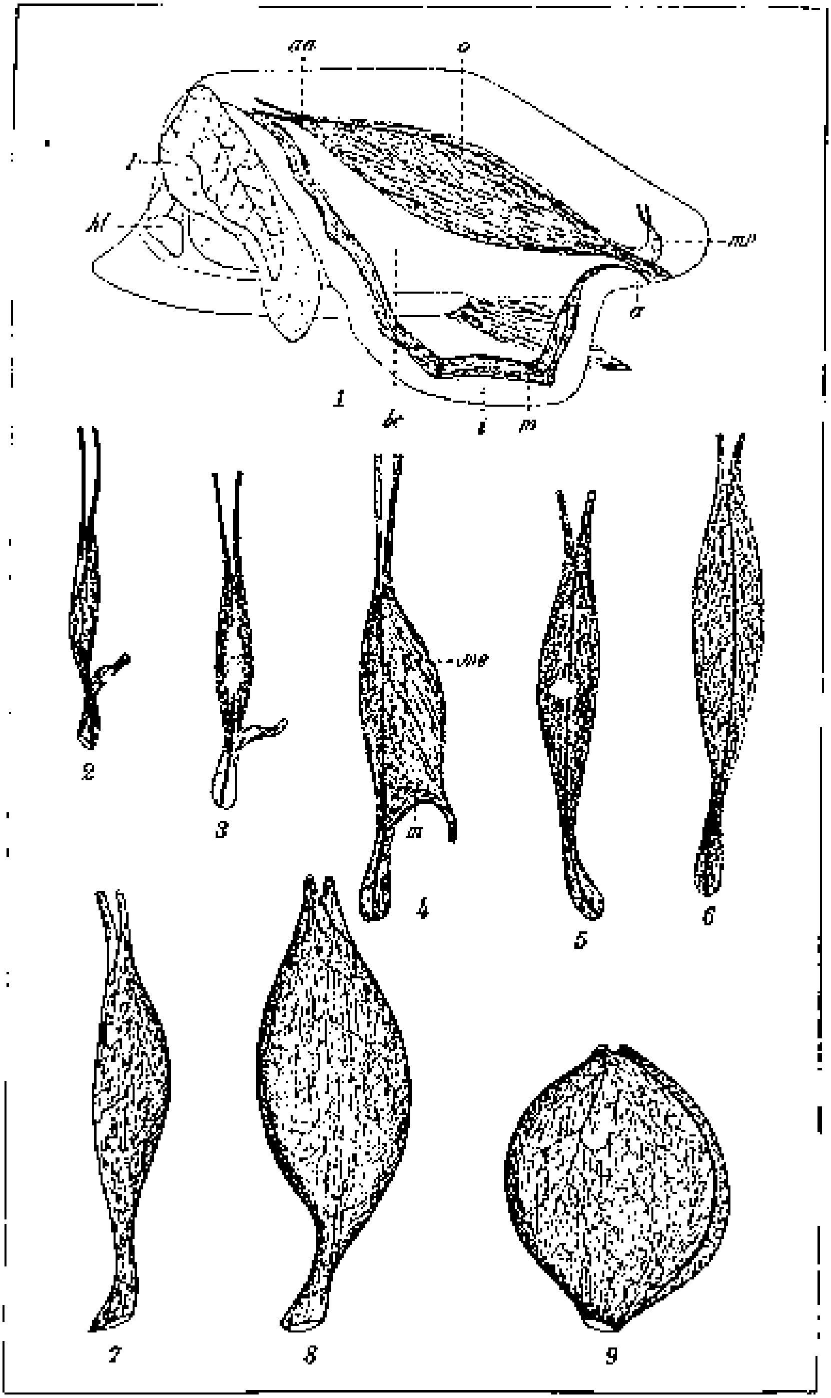
FIG. 15. Cross section through an ovarian follicle: arrangement of two maturing eggs, a blood vessel, and cuboidal cells bordering each side of follicle.
16. Cross section through a 1-cell egg stage within the ovarian follicle.
17. Cross section through an egg, early stage.
18. Cross section through an egg, later stage.
FIGS. 19 and 20. Gastrula stages of the eggs, October 22, 1932.
21 and 22. Lateral views of early embryos, November 14, 1932.
FIG. 23. Ventral view of an embryo, November 14, 1932.
24. Lateral view of an embryo, advanced stage, November 14, 1932.

PLATE 4. TÆNIOTOCA LATERALIS AGASSIZ

FIG. 25. Larva 3 mm long, December 21, 1929.
26. Larva 7 mm long, November 29, 1929.
27. Larva 12 mm long, February 2, 1932.

PLATE 5. TÆNIOTOCA LATERALIS AGASSIZ

FIG. 28. Larva 16 mm long, March 8, 1932.
29. Larva 21 mm long, March 21, 1932.
30. Larva 41 mm long, July, 1932.



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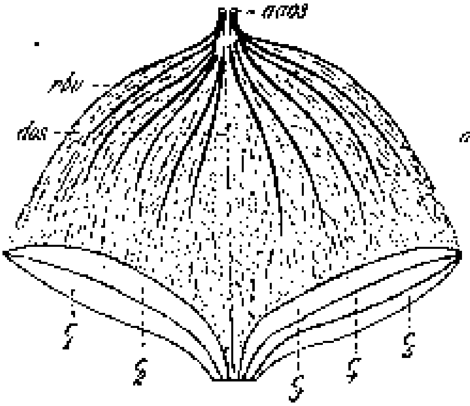

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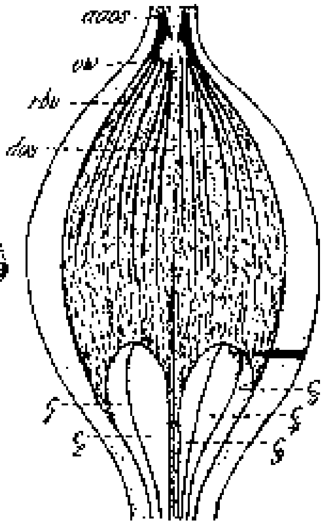

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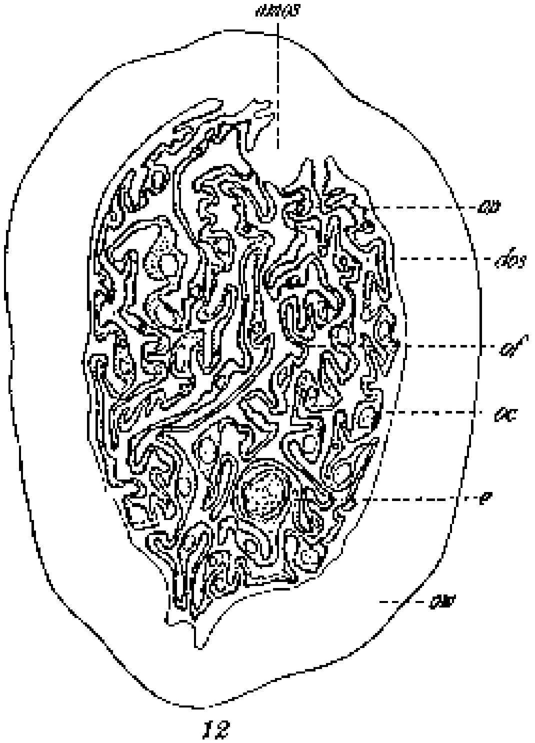

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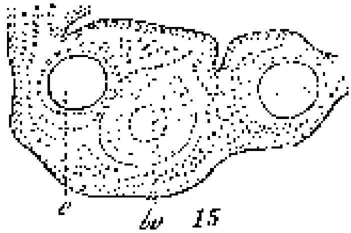
PLATE 2.



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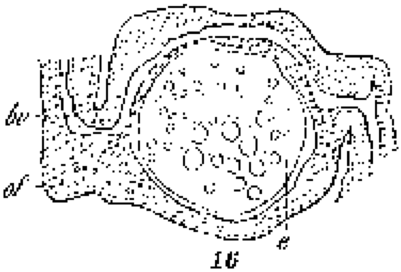

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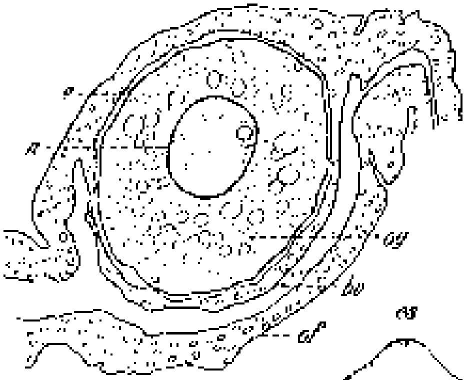

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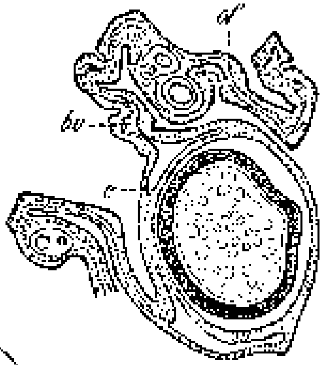

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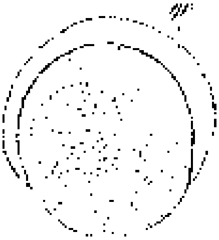

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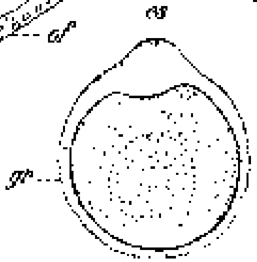

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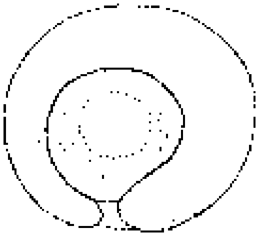

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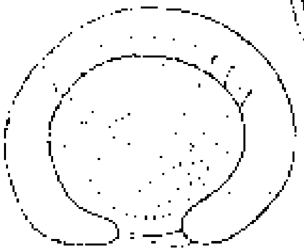

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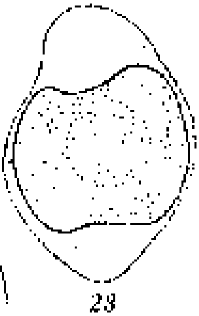

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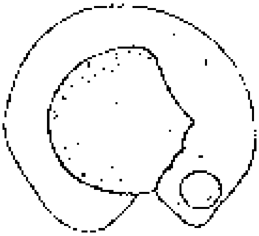

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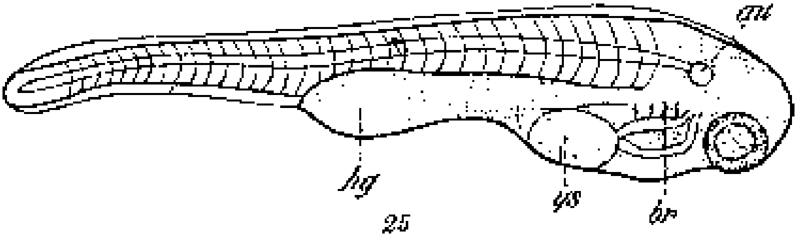
PLATE 3.



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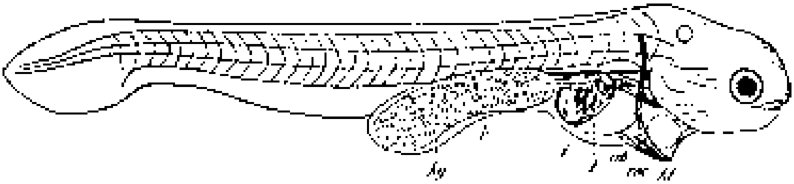

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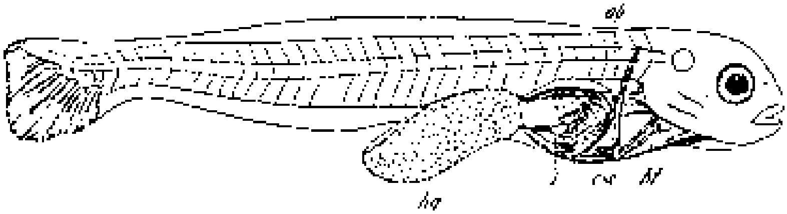

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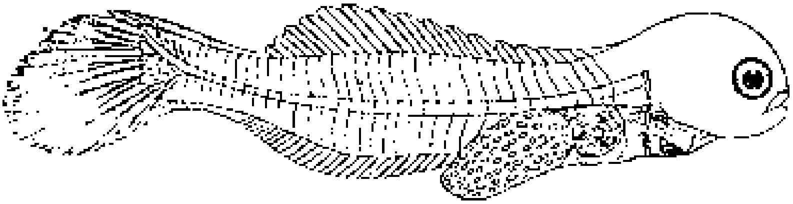
PLATE 4.



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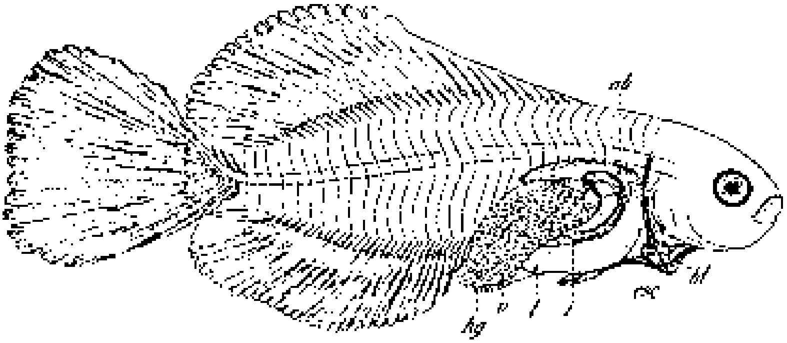

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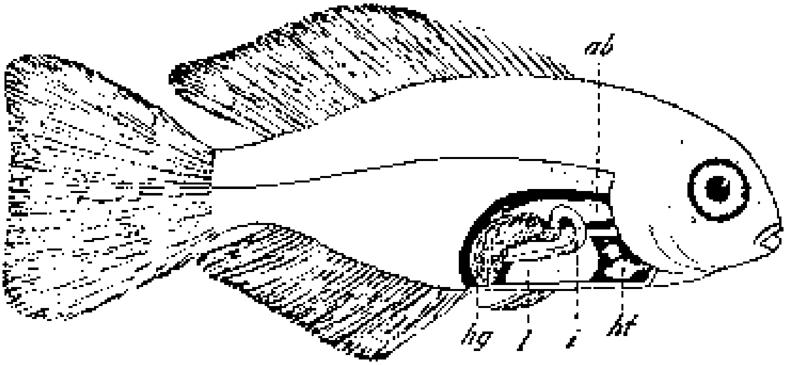

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PLATE 5.

ANIMALS DESTRUCTIVE TO OYSTERS IN BACOOR BAY LUZON

By Deogracias V. Villadolid and Domiciano K. Villaluz
Of the Fish and Game Administration, Bureau of Science, Manila

FOUR PLATES

Oyster farming in Bacoor Bay has in recent years been carried on a commercial scale. Along the entire coast of the Bay in Cavite Province, from Bacoor to Caridad, are extensive oyster beds (*pabiayan*). The methods now employed in oyster culture in Bacoor Bay are the stake method and the hanging method. The latter method was introduced in Bacoor Bay in 1935 by the Bureau of Science, and is now practiced by most of the oyster farmers, for it increases their harvest by 25 per cent over that secured by the stake method. During the harvest season of 1937 oysters gathered from Bacoor Bay seemed to meet the local demand for oyster meat in Cavite Province.

Although the oyster farms in Bacoor Bay are not yet menaced seriously by animals destructive to oysters, it is a necessary safeguard on the part of oyster raisers to be acquainted with the enemies of the oyster industry. In some oyster farms of the United States these animals have become serious enough pests to make their control a real problem. In New Jersey alone the estimated yearly damage caused by oyster drills amounts to more than one million dollars (Nelson, 1931).

OYSTER DRILL

The oyster drill (Plate 1, fig. 2) is a snaillike mollusc known among oystermen as screw borers. The most common species destructive to oysters in Bacoor Bay is *Urosalpinx ficula* Reeve. The shell of this mollusc is hard and exhibits different colors, from light brown to yellowish gray. The oyster drill possesses a powerful rasping tongue or radula, which it uses in boring holes through the shells of oyster. Once a hole has been made in the shells of the oyster, the radula is retracted and the proboscis, a slender fine tube, is protruded into the shell cavity, where it remains until the death of the oyster is effected.

Young oysters are the most common victims of the oyster drill, and the holes are bored into the thinnest part of the shell.

Oyster drills lay their eggs in groups, preferably on oyster shells (Plate 1, fig. 1). The eggs are contained in elongated capsules perpendicularly attached to the substratum by means of a solid expanded base. The egg cases are filled with a jelly-like substance which protects the eggs from mechanical injury.

STING RAYS

Sting rays (Plate 1, fig. 4) are cartilaginous fishes belonging to the genus *Dasyatis*. They are known to fishermen as whip ray, stingaree, and clam cracker. The most common species caught in the oyster farms in Bacoor Bay is the blue-spotted sting ray, *Dasyatis kuhli* (Müller and Henle). The body of this fish is disclike in form, dark brown to grayish brown above. The dorsal surface of the disc is marked with circular blue spots with black margins. The tail is brownish olive, and possesses a keel above and a fold below.

Rays often attack oysters during high tide, when they are able to enter oyster farms by swimming over the bamboo stakes surrounding them. They crack open the oysters so that only halves of oyster shells cemented to the stakes remain. Plate 6, fig. 3, shows a bamboo stake with oyster shells that have been attacked by sting rays. Stakes of this kind are commonly seen in oyster farms in Bacoor Bay.

SALT-WATER MUSSELS

Salt-water mussels (Plate 2, fig. 1) are bivalved molluscs, belonging to the family Mytilidæ. The most common edible species found living with oysters in Bacoor Bay is *Modiolus metcalfei* Hanley. The shell of this mussel is triangular, oblong, and swollen, greenish to yellowish brown outside with a band radiating from the umbo, smooth, finely striated and half covered towards the periphery with hairy brown covering.

Shortly after they are hatched, the mussels attach themselves to any stationary hard material, like growing oysters, by means of slender threads called byssi. As they mature these threads increase in number, and become stouter and shorter until the whole shell is firmly attached to the object. The mussels are gregarious, so that oysters are covered by the dense mats of their byssus threads, tending to limit the surface available for the oysters in feeding. Moreover, the mussels feed on the same organisms as the oysters, and as they grow they enter into keen competition with the latter as regards feeding activities. A great many of the oysters in bunches heavily infested with *Modiolus metcalfei* die, and those that survive are stunted in growth and possess lean meat.

POLYCLAD TURBELLARIAN

The turbellarian worm, *Pseudoceros* sp. (Plate 2, figs. 3 to 5) is known among oystermen as sea wafer or leech. This animal is thin and leaflike in shape and of a sinuous outline. The anterior margin is folded into S-shaped loops, and the posterior end is somewhat rounded. The dorsal surface is dark brown. This flat worm finds its way between the open valves of the oyster and feeds upon its meat. It appears in the oyster farms in Bacoor Bay during March and April, when the salinity of the water is quite high.

BORING MOLLUSC

The boring mollusc, *Martesia striata* Linn. (Plate 2, fig. 2), is known among oyster raisers as the boring "piddock." Its body is cylindrical, and the shell gaping. The dorsal edge is protected by two accessory valves, the anterior and the posterior valves. The beaks are covered, and the siphons unite in the form of a cylindrical tube with cilia at the end. The foot is stout and short.

The boring molluscs are indirectly injurious to oysters. After a brief period of free-swimming life the young burrowing shell fish settles down for the rest of its life in a burrow bored into the wood railings of the oyster plots (Plate 4, fig. 2). The burrows are often very near each other, so that the wood railings are dotted with holes. The latter appear externally as small openings, but internally the chambers are big, fitting closely with the outline of the animal shell. The wood railings attacked by these borers are very much weakened, and always fall to the bottom with the loads of oysters they bear. More than one-half of the oysters making up the oyster bunches have been observed to die once they drop to the bottom. During the harvest season of 1936 the oyster farmers in Bacoor Bay complained that they were able to gather only half of the oysters raised for that year due to the falling down of the railings attacked by these wood borers.

BARNACLES

The barnacles (Plate 4, fig. 1) are crustaceans belonging to the family Balanidæ. Those that are commonly found in Bacoor Bay are *Balanus rostratus* Hoek. The shells are almost smooth and sometimes ribbed in places. The walls and opercular plates are almost entirely white, and the orifice, which is egg-shaped, is about half as long as the base. These barnacles are very destructive to oysters, especially to the spats that have just set. They grow very close to each other and in large numbers where oyster spats have settled, so that the latter die due to lack of space for growth and feeding. Barnacles also grow abundantly on shells of mature oysters (Plate 1, fig. 3). The effect is detrimental to the oysters, whose growth is inhibited and who consequently often possess thin meat.

CONCH

The most common conch in Bacoor Bay is *Melongena pugilina* Born (Plate 3, figs. 1 and 2). The egg cases of this conch are very much flattened and filled with jellylike fluid which protects the eggs from mechanical injury. These molluscs open the oysters by inserting the edges of their snouts between the gaping valves. The oysters are finally killed by the radula or the rasping tongues of the conch. In Bacoor Bay conches do not occur in great enough numbers to destroy many oysters.

Melongena pugilina is inflated, thick, and mango-shaped. Its shell is dark brown, and provided with hairy velvety epidermis. The whorls are lined with tubercles and spirally ridged towards the apex.

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ILLUSTRATIONS

PLATE 1

FIG. 1. Egg capsules of *Urosalpinx scala* Reeve.
2. *Urosalpinx scala* Reeve.
3. Barnacles growing on mud of oysters.
4. *Dasyatis kuhlii* (Müller and Henle).

PLATE 2

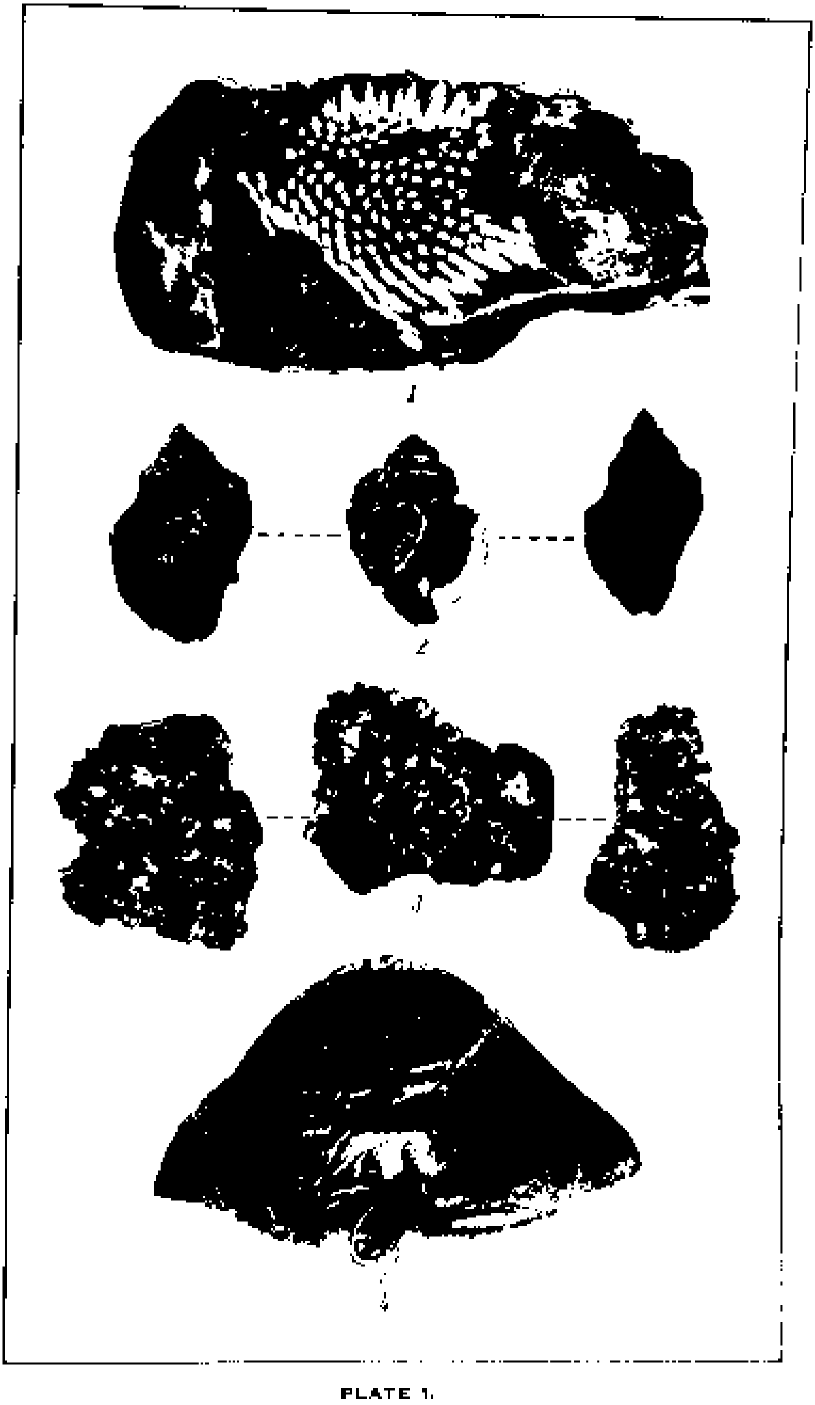
FIG. 1. *Modiolus metcalfei* Hanley.
2. *Martesia striata* Linn.
FIGS. 3 to 5. *Pseudoceros* sp.

PLATE 3

FIG. 1. Egg capsules of *Melongena pugilina*.
2. *Melongena pugilina* Born.

PLATE 4

FIG. 1. String of oysters covered with barnacles.
2. Wood railing attacked by *Martesia striata* ("nidblock").
3. Bamboo stake with oysters attacked by sting ray.



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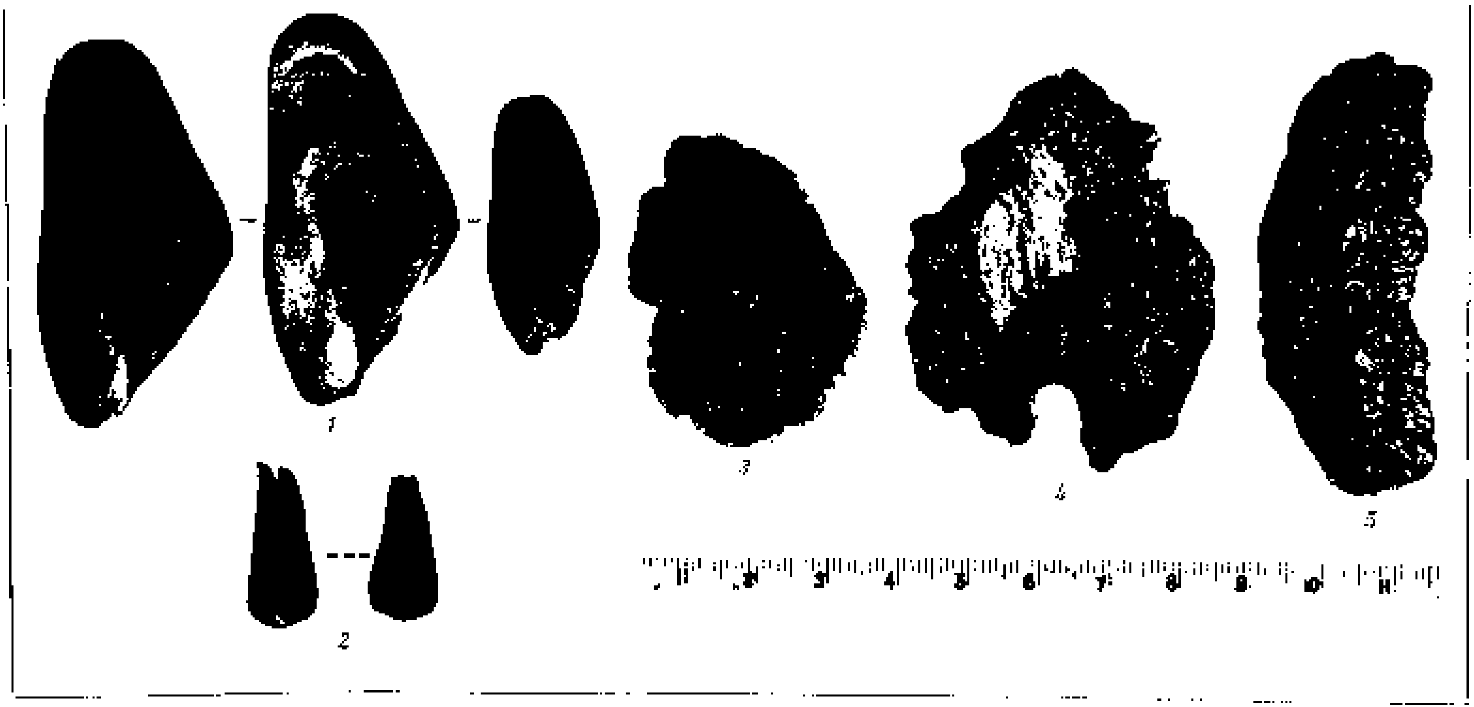

PLATE 2.

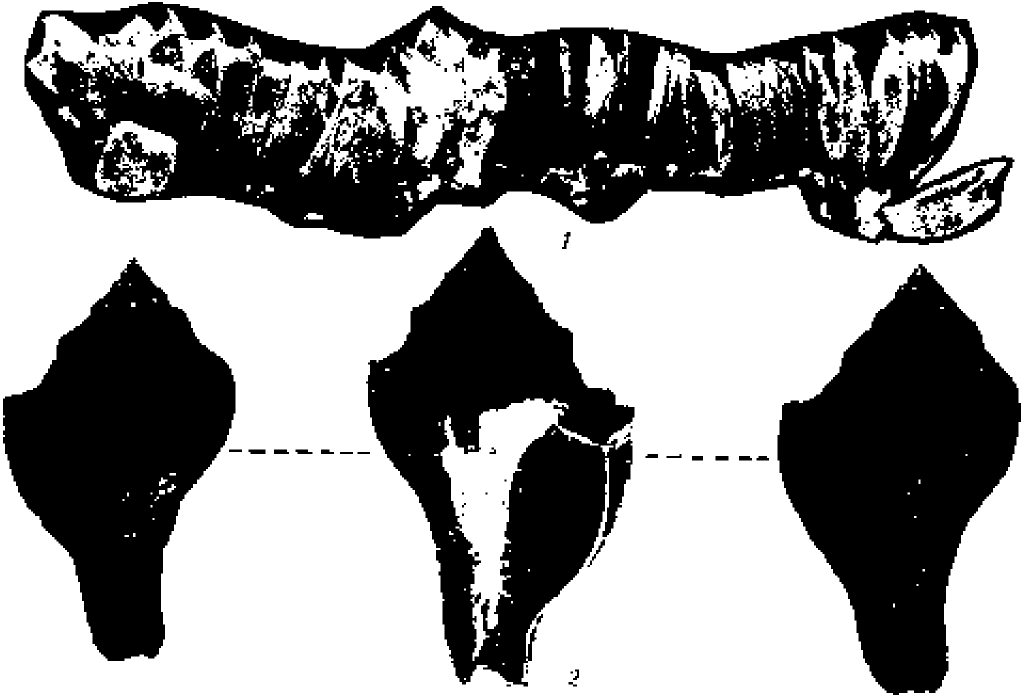

PLATE 3.

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PLATE 4.

NEW GLASS-EYE MUTATION, A SEX-LINKED CHARACTER IN DROSOPHILA

By Leopoldo S. Clemente and Gregorio Ong

Of the Department of Zoölogy, University of the Philippines, Manila

ONE PLATE

Müller in 1918, as cited by Bridges and Morgan,(1) found a mutation in *Drosophila* in the stock "sable-duplicate garnet" with colorless eyes having a smooth surface which he called "glass." In 1919 Mohr, cited by the above authors, rediscovered exactly the same mutation, also in the "sable-duplicate garnet" stock. This glass-eye mutation is characterized by a loss of the separate character of the facets, which form a continuous smooth glassy surface. The eyes are very much reduced, only one half the size of the normal eyes. The reduction in size of the eye is mainly in the anteroposterior direction and it is most pronounced at the bottom and top of the eye, giving it a diamond shape in general appearance. The superficial layer of the eye is generally colorless, or, when the color is present, it is of a diffuse straw-colored tinge, while its deeper portions are more heavily pigmented. The color of the eye is different in the two sexes, being darker in males than in females. In the case of the female the color of the deeper layer is often reduced to a mere tinge similar to that of the poorly pigmented superficial layer, while in the case of the male the color of the deeper layer is usually vermilion or orange.

Genetic data obtained by Müller and by Mohr clearly show that their glass mutation is an autosomal third chromosome mutation and is recessive to normal eye. Its locus is at 63.1, or the section between "hairless" which is located at locus 69.5, and "spineless" which is located at locus 58.5. This glass mutation is normal in viability and productivity.

In this paper, however, a "new glass-eye" mutation was found among the offspring resulting from crossing two mutants obtained from the Philippine wild *Drosophila*, resembling in many ways the glass mutant discovered by Müller and by Mohr, but of entirely different genetic behavior. This "new glass-eye" mutation is a sex-linked character instead of being autosomal as is the case of the mutation found by Müller and by Mohr.

The authors are indebted to Mr. Jose V. Yap-Chiongco, who helped them carry on the genetic tests, and to Mr. Rafael Dayaw, who has kindly drawn the colored illustrations.

MATERIALS AND METHODS

The "new glass-eye" mutation reported in this paper was found in the cross involving eyeless and orange-eyed mutants with moruloid facets, which at the same time is a carrier of purple in an epistatic condition to orange. The eyeless mutant was discovered by the senior author(2) June 22, 1926, in the Manila bandless *Drosophila*, and until now is still breeding true to type in our laboratory. The eyeless fly possesses a very much reduced head, due to the total or partial disappearance of the ommatidia of the compound eyes. The simple eyes or ocelli are also absent. Occasionally there are found, among the eyeless stock, flies with a minute eye on the left side, some with a minute eye on the right side, and a very few with two small eyes on one side and only one small eye on the other side. According to unpublished data of Clemente and Nemenzo,(3) these eye variations of the eyeless stock are not hereditary, because selection experiments of different eye variations failed to produce positive results.

Eyeless flies are also carriers of the red-color factor, as shown by the fact that whenever flies with little eyes appear, the eyes are red. Moreover, when eyeless flies are mated to nonred-eyed flies, such as purple-eyed, the offspring are always red-eyed. Eyeless is a mutation of the fourth chromosome and is independent of orange, morula, and purple.

The orange-eyed fly with moruloid facets was discovered by Mr. Francisco Nemenzo in the purple-eyed stock in August, 1929, and until now is still breeding true to type. This mutation is characterized by eyes that are slightly reduced in size as compared with normal, and of orange color. The orange shade varies somewhat with age, being lighter in young flies and darker in old ones. The orange color is uniformly distributed throughout the eyes with the same intensity at the peripheral region as well as at the center. The facets upon microscopic examination are found to be irregular in shape, size, and arrangement, similar to the "morula eye" mutant of Altenburg and Müller, the "rough eye" mutant of Müller, and the "roughoid eye" mutant of Strong, as cited by Bridges and

Morgan.(1) The minute hairs or microtrichia which are found on the surface of the eyes are also present, as in normal flies. The orange-eyed fly, in addition to carrying morula, also carries purple in a hypostatic condition. Unpublished work of Clemente and Nemenzo(4) indicates that orange and morula are autosomal linked characters, probably of the third chromosome, and are recessive to the red-eye and normal facets respectively, while purple is a second chromosome mutation which is recessive to its red allelomorph.

The usual method of rearing and breeding the flies commonly employed in our laboratory was used. The flies were kept throughout the experiment inside the frigidaire at a more or less constant temperature of 25° C., because at much higher temperature the flies do not breed very well.

HISTORY OF THE "NEW GLASS-EYE" MUTATION

The first "new glass-eyed" fly was observed by the junior author February 6, 1931, among the offspring of the cross involving eyeless and orange-eyed stocks with morula facets. From the first up to the thirteenth individual of this new eye mutation only males were found. This fact gives us a clue that this "new glass eye" is probably a sex-linked character and not autosomal as in the case of the glass eye of Müller and of Mohr.

The mating from which this "new glass-eye" mutation resulted was between female eyeless and male orange-eyed flies. This mating produced only red-eyed F_1 flies with normal facets. Upon mass mating the F_1 flies the following F_2 phenotypes were produced: Red-eyed with normal facets; orange-eyed with moruloid facets; purple-eyed with normal facets; purple-eyed with moruloid facets; and eyeless.

The F_2 orange-eyed flies were again back-crossed to red-eyed stock with normal facets, and this mating produced only red-eyed flies with normal facets. Upon mass mating the red-eyed flies of this backcross, offspring of the following phenotypes were produced: Red-eyed with normal facets; purple-eyed with normal facets; purple-eyed with moruloid facets; orange-eyed with moruloid facets, eyeless, and some "new glass-eyed" flies as the mutation. Glass eye is considered a mutation because it is not expected as one of the segregates in the cross, for it is very different from the parents or immediate ancestors. Moreover, the characters involved in the cross are autosomal, whereas the "new glass-eye" mutation is sex-linked. The occurrence of mutation in crosses is not new, for similar cases have been observed by other investigators; such as the "spread wing" of Dexter, a third chromosome mutant as cited by Morgan and Bridges(5) which was found in a cross between "beaded" and "vestigial" mutants.

The following record is an account of the appearance of the first thirteen glass-eyed flies, all males, as they were found from day to day. It also shows the total number of flies among which they were found, together with the record of their matings, offspring when present, and their deaths. Certain data with regard to the flies, such as vigor and intensity of eye color, were also recorded.

First mutant, a male, found February 6, 1931, among 30 flies. Mated to 8 orange female sibs. Died on the third day after mating. Left no offspring.

Second mutant, a male, found February 16, 1931, among 78 flies. Mated to several purple female sibs. Died on the third day. Left no offspring.

Third mutant, a male, found February 20, 1931, among 35 flies. Mated to 4 morula female sibs. Died on the following day. Left no offspring.

Fourth mutant, a male, found February 25, 1931, among 15 flies. Small, dark-eyed, and weak. Mated to some morula female sibs. Died on the fifth day. Left no offspring.

Fifth mutant, a male, found March 3, 1931, among 23 flies. Small, dark-eyed, and weak. Died soon after it was found.

Sixth mutant, a male, found March 6, 1931, among 48 flies. Small, with light-colored eyes, and weak. Mated to morula female sibs. Died on the third day. Left no offspring.

Seventh mutant, a male, found March 6, 1931, among 16 flies. Dark-eyed, strong, vigorous, and could fly around. Mated to several morula female sibs. Eggs were laid but failed to hatch. Died on the eighth day.

Eighth mutant, a male, found March 7, 1931, among 25 flies. Dark-eyed and weak. Mated to morula female sibs. Died on second day. Left no offspring.

Ninth mutant, a male, found March 9, 1931, among 17 flies. Dark-eyed and weak. Mated to morula females. Died on the third day.

Tenth, eleventh, and twelfth mutants, all males, found March 10, 1931, among 38 flies. Two dark-eyed and one light-eyed. All weak, died the same day they were found.

Thirteenth mutant, a male, found March 11, 1931, among 8 flies. Dark-eyed, big, strong, and vigorous. Mated to several morula female sibs. Eggs laid March 17, 1936, from which the following were produced: 29 Red-eyed, 7 purple-eyed, and 2 dark glass-eyed females.

DESCRIPTION OF THE "NEW GLASS-EYE" MUTATION

This new mutation was called "glass eye" because of the shiny surface of the eyes of the flies affected. The glassy appearance is especially well manifested whenever bright light falls on the surface of the eyes. The eyes are very much reduced in size, to about one-half that of normal. The reduction is greatest on the anterior and posterior borders, thus making the eyes appear spindle-shaped (Plate 1). There is a wide periphery of colorless area surrounding the eye as a result of the reduction in size.

There are three shades of eye color among the glass-eyed mutants. They are light, medium, and dark, but the most frequent is the dark (Plate 1). The color in all these shades is uniformly distributed all over the eyes, unlike the glass eye of Müller and of Mohr in which the color is unevenly distributed. The different shades cannot be due to difference in age of the flies, for all of the three shades were found even among the newly emerged flies. Neither is the color different in the two sexes as is true of the glass eye of Müller and of Mohr. The difference in intensity of the color of glass eye is perhaps due to the interaction of genetic factors, such as orange eye, purple eye, and red eye, which are present in the mutating stock. Our unrecorded breeding observations seem to indicate that the dark glass eye can produce all the three color shades; the medium glass eye can produce both medium glass and light; whereas the light glass eye can produce only light.

When seen under the microscope, the eyes are found to be devoid of hairs on the surface, and instead of having facets of hexagonal partitions as in normal eyes, they form a continuous single shiny mass very similar to glass. In other words, the eyes are hairless and facetless, similar to the ocelli or simple eyes of insects. Whether or not the ommatidia have also lost their separate character is not known, for no serial sections of the eyes have been made. There is no doubt but that the absence of both the hair and facets are responsible for giving the glassy or shiny appearance to the eyes.

The glass-eyed flies are weak, rather small in size, and, as a rule, short-lived. They are not as active nor prolific as the normal flies. They do not fly around actively as do normal flies, and usually die a few days after emerging from the pupal cases. In most instances they live only for three days. Breeding data seem to indicate that many of them die before they reach the adult stage.

GENETIC BEHAVIOR OF THE "NEW GLASS-EYE" MUTATION

Mating of the new glass-eyed males and females.—Several matings of glass-eyed males and females were made primarily for the purpose of producing a pure breeding stock of this new eye mutation. To our surprise, no offspring was produced in all our matings, and thus we failed in our attempt to produce the pure stock of glass-eyed flies. Thus the only way to carry on this new eye mutation was to mate the glass-eyed males to normal females which are either homozygous normal or are carriers of the glass mutation, because pure glass-eyed females were found to be sterile.

Mating of the new glass-eyed flies to normal.—In our attempt to study the genetic behavior of this new eye mutation, crosses were made between glass-eyed females and normal males as well as their reciprocal crosses. Again, to our surprise, whenever glass-eyed females were mated to normal males the mating was sterile, but whenever the glass-eyed males were mated to normal females the mating was always fertile. It seems that this new glass-eye gene causes sterility whenever it is found in a double dose as in the glass-eyed female, and that whenever it is found only in a single dose as in the glass-eyed male, the effect is not enough to cause sterility. This finding is similar to that of Mohr as cited by Bridges and Morgan(1) in the case of the third chromosome mutant "varnished," and of that of Morgan and Bridges(5) in the case of the sex-linked "rudimentary wings." According to Morgan and Bridges the reason for these perfectly fertile males and perfectly sterile females is that the germ cells cease to develop in the early growth stage of the eggs while the spermatozoa undergo normal development. Whether or not this explanation of Morgan and Bridges holds true in our case is not known.

Mating of glass-eyed males to normal-eyed females.—The mating of glass-eyed males to normal-eyed females was first resorted to primarily because of the sterility among the glass-eyed females, and secondarily because the only glass-eyed mutants available at the beginning were males. Inasmuch as the glass-eyed males are weak, several males were mated to a number of normal females. This type of mating was used because it gave better results than when only one glass-eyed male was used at a time. If glass eye is really a sex-linked recessive gene, this mating of glass-eyed males, *g*—, to normal females, *GG*, should produce normal males of the genotype *G*— and normal females of the genotype *Gg*. This expected result was obtained, as can be seen in Table 1. There are 125 females and 117 males, which are all normal-eyed like the wild parent. The expected 1 : 1 ratio of males to females was also realized, with but a slight deviation. The sex-linked recessive nature of this new glass-eye mutant is further demonstrated in the following mating, when the F_1 of this cross were mated together en masse to produce the F_2 generation.

TABLE 1.—*Glass-eyed male × normal-eyed female.*

Results.	Normal-eyed.	
	Female.	Male.
Number obtained	125	117
Number expected	121	121
Deviation	+4	−4
Expected ratio	1	1

Mating of the F_1 flies en masse.—Table 2 shows the result of the mating of the F_1 en masse to produce the F_2. Theoretically, according to the sex-linked inheritance, there should be expected in this mating between normal females of the genotype *Gg* and normal males of the genotype *G*— offspring in the proportion of 2 normal females of the genotypes *GG* and *Gg*: 1 normal male of the genotype *G*—: 0 glass-eyed females: 1 glass-eyed male of the genotype *g*—. This expectation was realized, as there were obtained 151 normal-eyed females, 102 normal-eyed males, 0 glass-eyed females, and 25 glass-eyed males. The absence of glass-eyed females and the presence of glass-eyed males in the F_2 is a clear indication that glass eye is a sex-linked character and is recessive to normal eye. The fewness of F_2 male glass-eyed individuals in proportion to the numerous normal-eyed males and females as can be seen by their minus deviation may be explained by the general weakness and poor viability of the glass-eyed individuals, as was observed at the very beginning.

TABLE 2.—F_1 *normal-eyed male* × F_1 *normal-eyed female.*

Results.	Normal-eyed.		Glass-eyed.	
	Female.	Male.	Female.	Male.
Number obtained	151	102	0	25
Number expected	139	69.5	0	69.5
Deviation	+12	+32.5	0	−44.5
Expected ratio	2	1	0	1

Back-crossing the F_1 *normal-eyed females to glass-eyed males.*—Table 3 shows the result of the back-crossing of the F_1 normal-eyed females of the genotype *Gg* to glass-eyed males of the genotype *g*—. As is expected according to sex-linked interpretation of glass eye, there should be normal-eyed females of the genotype *Gg;* glass-eyed females of the genotype *gg;* normal males of the genotype *G*—; and glass-eyed males of the genotype *g*— in equal numbers. This expectation was realized, as there were produced 75 normal-eyed females, 74 normal-eyed males, 23 glass-eyed females, and 20 glass-eyed males. There are again a relatively small number of glass-eyed individuals in both sexes where equality in number with the normal is expected, thus indicating once more the poor viability of the flies possessing the glass-eye gene.

TABLE 3.—*Glass-eyed male* × F_1 *normal-eyed female.*

Results.	Normal-eyed.		Glass-eyed.	
	Female.	Male.	Female.	Male.
Number obtained	75	74	23	20
Number expected	48	48	48	48
Deviation	+27	+26	−25	−28
Expected ratio	1	1	1	1

Mating of glass-eyed males to F_2 *normal-eyed females.*—The results of mating the F_2 normal females to glass-eyed males are shown in Table 4. Theoretically, as stated before, there are two genotypes in equal number among the F_2 normal females; one is homozygous normal, *GG*, while the other is heterozygous normal, *Gg*. Upon mass mating a number of these F_2 females to a number of glass males, *g*—, we expect a 3 : 1 ratio in both sexes between normal-eyed and glass-eyed flies, respectively. This theoretical result was obtained, as can be seen in Table 4. There were produced 90 normal-eyed females of the genotype *Gg*, 86 normal-eyed males of the genotype *G*—, 20 glass-eyed females of the genotype *gg*, and 28 glass-eyed males of the genotype *g*—. Again, there is a slight minus deviation in the glass-eyed females, due to their poor viability.

TABLE 4.—*Glass-eyed male* × F_1 *normal-eyed female.*

Results.	Normal-eyed.		Glass-eyed.	
	Female.	Male.	Female.	Male.
Number obtained	90	86	20	28
Number expected	84	84	28	28
Deviation	+6	+2	−8	0
Expected ratio	3	3	1	1

Mass-mating of F_2 *normal-eyed males and females.*—As was stated above, there are two genotypes of equal number among the F_2 normal females, *GG* and *Gg*. On the other hand, there is but one genotype of F_2 normal males, *G*—. Upon mass-mating of the F_2 normal males and females there would be expected, according to the sex-linked inheritance of glass eye, a ratio of 4 normal females : 3 normal males : 0 glass-eyed females : 1 glass-eyed male. This expectation (Table 5) was realized, although again there is a minus deviation among the glass-eyed males due to their general weakness. There were obtained 131 normal females of the genotypes *GG* and *Gg*, 92 normal males of the genotype *G*—, 0 glass females, and 23 glass-eyed males of the genotype *g*—. The total absence of glass-eyed females and the presence of glass-eyed males in this mating is again a clear indication that glass eye is a sex-linked character and is recessive to normal eye.

TABLE 5.—*Mass mating of* F_2 *normal-eyed male and female.*

Results.	Normal-eyed.		Glass-eyed.	
	Female.	Male.	Female.	Male.
Number obtained	131	92	0	23
Number expected	123	92.25	0	30.75
Deviation	+8	—.25	0	—7.75
Expected ratio	4	3	0	1

SUMMARY AND CONCLUSIONS

1. A new mutation in *Drosophila* was found in which the flies affected possess facetless, hairless, smooth, shiny, and glass-like eyes.

2. The glass eyes are reduced in size, with the anterior and posterior borders being greatly reduced, while the dorsoventral portions are slightly reduced.

3. Three color shades of glass eye were found, which can be classified into dark, medium, and light. This difference in eye shade may be due to genetic factors, inasmuch as the dark shade can produce all the three colors; the medium can produce only medium and light shades, while the light color breeds true.

4. Genetic tests have conclusively proven that this new glass-eye mutation is sex-linked and recessive to normal eye, and not autosomal as was the glass eye of Müller and of Mohr.

5. Glass-eyed females were found sterile while glass-eyed males were found fertile. This may be due to the double glass-eye genes in females and the single glass-eye gene in males.

6. Glass-eyed flies are generally weak, short-lived, and not prolific. They live only a few days after emergence from the pupal cases. Their number is usually less than expected, because of their general weakness.

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ILLUSTRATION

PLATE 1

Fig. 1. Light glass-eyed fly.
2. Medium glass-eyed fly.
3. Dark glass-eyed fly.

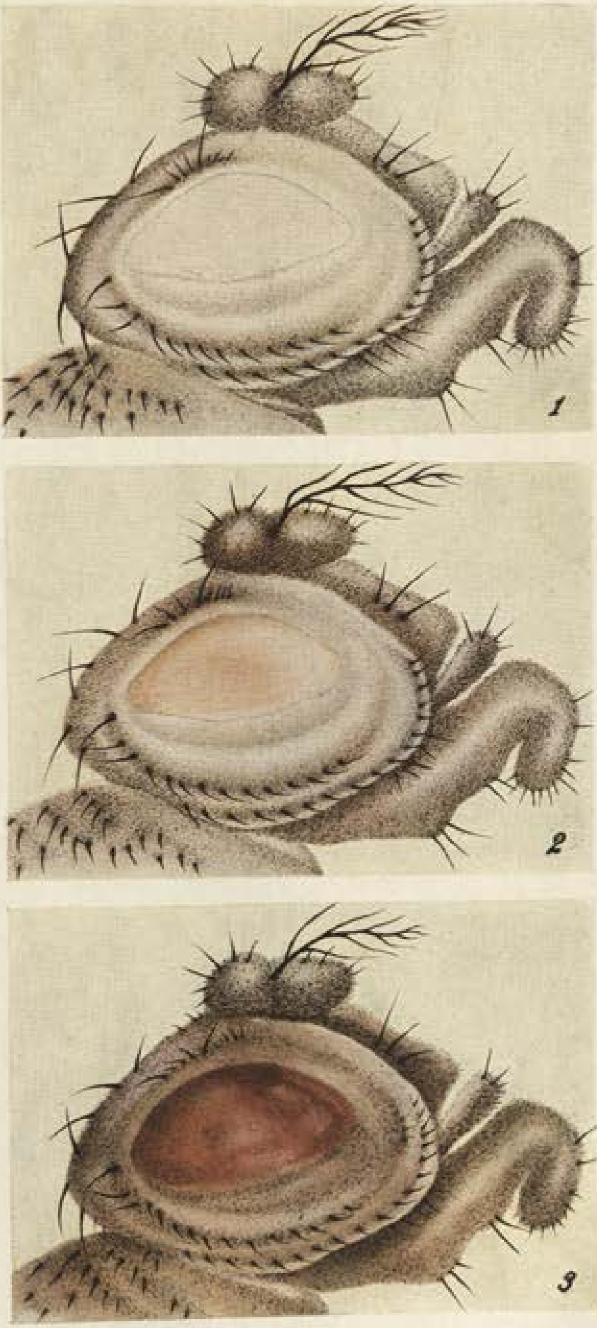

PLATE 1.

NOTES ON THE ALGAL FLORA OF NEW ZEALAND, II

FRESH-WATER ALGÆ FROM NAPIER

By B. W. Skvortzow
Of Harbin, Manchoukuo

ONE PLATE

The present paper on fresh-water algæ has resulted from the examination of algal material received from Mr. Ian C. Edmundson, of Napier, New Zealand, who collected it from an aquarium. The sample consists of greenish masses of immense growth of *Scenedesmus brasiliensis* Bohlin, among which I have noted 4 species of Flagellatæ and 28 species of Diatomaceæ.

The following features may be pointed out in connection with the diatom flora of this sample. (*a*) About 30 per cent of all diatoms here recorded are new to New Zealand; (*b*) almost all the diatoms are fresh-water species, except *Diploneis Smithii* Breb. and *Rhopalodia gibberula* (Ehr.) O. Müll. var. *Van Heurckii* O. Müll., common in brackish water; (*c*) *Cyclotella Meneghiniana* Kütz. var. *Novae Zealandiae* var. nov., *Diploneis subovalis* Cleve fo. *Novae Zealandiae* fo. nov., and *Rhopalodia Novae Zealandiae* Hustedt var. *ventricosa* var. nov. are proposed as new. The types of the two latter diatoms have been described by P. T. Cleve and Fr. Hustedt as endemic for New Zealand.

All algæ collected by Mr. I. C. Edmundson are here described and illustrated by me. The diagrams were made with E. Leitz Apochromat 2 mm and Compens Okular 4 in my laboratory in Harbin.

FLAGELLATÆ

TRACHELOMONAS VOLVOCINA Ehr. Plate 1, fig. 23.

Trachelomonas volvocina Ehr., G. Deflandre, Monogr. Genre Trachelomonas Ehr. (1926) 35, fig. 1 *a*, *b*.

Shell spherical, reddish brown, smooth. Chromatophores distinct and green. Diameter of shell, 0.01 to 0.011 mm; neck, 0.0017 mm broad. Common. Reported from fresh water.

TRACHELOMONAS HISPIDA (Perty) Stein var. SUBARMATA Schröder. Plate 1, fig. 32.

Trachelomonas hispida (Perty) Stein var. *subarmata* Schröder, SKVORTZOW. New Phytologist (5) 24 (1925) 300, fig. 2; LEMMERMANN, E. Eugleninae (1913) 149, 150, fig. 572.

Shell dark brown, oval, with broad-rounded ends, covered with sharp-pointed spines, 0.017 mm long, 0.013 mm broad. Aperture for flagella 0.0017 mm broad, without a tubelike neck. Chromatophores numerous. Common.

TRACHELOMONAS OBLONGA Lemm. Plate 1, fig. 29.

Trachelomonas oblonga Lemm., G. DEFLANDRE, Monogr. Genre Trachelomonas (1926) 63, figs. 121, 124.

Shell elliptic-globose, minute, brown, smooth. Chromatophores several. Shell 0.0119 mm long, 0.01 mm broad. Aperture for flagella about 0.0015 mm broad. Infrequent.

TRACHELOMONAS HAMILTONIANA sp. nov. Plate 1, figs. 30 and 31.

Lorica oblonga ubique rotundata. Collo nullo. Membrana fusca crassa, scrobiculato-punctata. Chloroplastis numerosis, disciformibus. Longis 0.017 mm; latis 0.013; ore 0.0017 latis. Habit in aquis dulcis stagnalis prope Napier, N. Z. Legit I. C. Edmundson.

Shell oval or elliptical, with rounded ends. Membrane fine-scrobiculate, brown. Aperture for flagella without a tubelike neck, 0.0017 mm broad. Chlorophores numerous. Shell 0.017 mm long, 0.013 mm broad. Infrequent. Forms with scrobiculate membrane are easily identified from *Trachelomonas abrupta* Swirenko by the form of the shells. Named in honor of Mr. A. Hamilton, Wellington, New Zealand, a naturalist and an enthusiastic collector.

CHLOROPHYCEÆ

SCENEDESMUS BRASILIENSIS Bohlin. Plate 1, fig. 19.

Scenedesmus brasiliensis BOHLIN, Jos. Brunnthaler, Protococcales (1915) 165, fig. 222.

Cœnobia flat, of 2 to 4 cells arranged in a single linear series. Cells ovoid-ellipsoid, with a distinct longitudinal ridge extending from the pole on each side of the cell. Poles with 2 or 3 small teeth. Cells 0.011 to 0.014 mm long, 0.0034 to 0.0042 mm broad. Four-celled cœnobia 0.017 to 0.02 mm long. Abundant. Reported from Europe and America.

DIATOMACEÆ

CYCLOTELLA MENEGHINIANA Kütz. var. NOVAE ZEALANDIAE var. nov. Plate 1, fig. 18.

Valvis circularis, 0.0085 mm in diametris. Striis robustris ad centrum percurrentes. Centrum minor et hyalina. Habit in aquis dulcis stagnalis prope Napier, N. Z. Legit I. C. Edmundson.

Valve flat-circular, with distinct outer area a band ¼ the radius in width, strongly marked with closely set radiating costæ, 0.012 to 0.014 mm. Circular central area hyaline. Diameter 0.0085 mm. Differs from the type in the smaller size, the sparse striæ, and the presence of a little hyaline center. Rare.

MERIDION CIRCULARE Agardh. Plate 1, fig. 25.

Meridion circulare Agardh, FR. HUSTEDT, Bacillar. (1930) 130, 131, fig. 118.

Valve clavate. Apex broad-rounded, tapering to elongate, subacute ends. Length, 0.0476 mm; breadth, 0.0003. Rare. Common in mountain streams. Reported from New Zealand.

MERIDION CIRCULARE Agardh var. **CONSTRICTA** (Ralfs) Van Heurck. Plate 1, fig. 18.

Meridion circulare Agardh var. *constricta* (Ralfs) Van Heurck, FR. HUSTEDT, Bacillar. (1930) 131, fig. 119.

Valve subclavate, needle-shaped, with capitate elongate apex and attenuate end. Length, 0.044 mm; breadth, 0.0058. Infrequent. Common in running water.

SYNEDRA ULNA (Nitzsch) Ehr. Plate 1, figs. 6, 7, and 33.

Synedra ulna (Nitzsch) Ehr., FR. HUSTEDT, Bacillar. (1930) 159; A. SCHMIDT, Atlas Diatom. (1914) pl. 301, figs. 1–26.

Valve linear, with parallel margins and subrostrate rounded ends. Length, 0.162 mm; breadth, 0.0058 to 0.0085. Striæ 8 in 0.01 mm. Common; almost in fragments. Reported from New Zealand.

COCCONEIS PLACENTULA Ehr. Plate 1, fig. 4.

Cocconeis placentula Ehr., FR. HUSTEDT, Bacillar. (1930) 189, 190, fig. 260.

Valve broad-elliptic, with rounded ends. Length, 0.017 mm; breadth, 0.0085. Striæ about 28 in 0.01 mm. Infrequent. Reported from New Zealand.

ACHNANTHES COARCTATA Bréb. Plate 1, fig. 37.

Achnanthes coarctata Bréb., FR. HUSTEDT, Bacillar. (1930) 210, fig. 308a.

Valve linear-elliptic, slightly constricted in the middle, with subrostrate rounded ends. Length, 0.022 mm; breadth, 0.0068. Striæ radiate, punctate, 15 in 0.01 mm, forming from lower part of valve a distinct broad fascia. Infrequent. Known from fresh water and moist earth. Reported from New Zealand.

DIPLONEIS SMITHII Bréb.? Plate 1, fig. 23.

Diploneis Smithii Bréb., FR. HUSTEDT, Bacillar. (1930) 253, fig. 402.

Valve elliptic, ovate, with slightly attenuate and rounded ends. Length, 0.0272 mm; breadth, 0.017. Median line straight. Central nodule of median size; furrows narrow. Transverse rows of alveoli radiate. Costæ with double rows of alveoli, 7 in 0.01 mm. Infrequent. A brackish-water species. New Zealand.

DIPLONEIS SUBOVALIS Cleve fo. **NOVAE ZEALANDIAE** fo. nov. Plate 1, fig. 27.

Valvis ovalis, prae forma typica latior, lateribus modice arcuatis, polis vastis, rotundatis. Alveolae 5 vel 6 in 0.01 mm, poris duabis. Valvis longis 0.0306 mm; latis 0.017. Habit in aquis dulcis stagnalis prope Napier, N. Z. Legit I. C. Edmundson.

Differs from the type in its valves being more ovate, subrhomboid, and its more distinct costæ. The type is known from Paeroa, New Zealand.

DIPLONEIS PUELLA (Schumann) Cleve forma. Plate 1, fig. 26.

Diploneis puella (Schumann) Cleve, FR. HUSTEDT, Bacillar. (1930) 250, fig. 394.

Valve elliptic, with rounded ends. Length, 0.0233 mm; breadth, 0.015. Costæ robust, 10 or 11 in 0.01 mm, very indistinctly striate. Infrequent. Differs from the type in its more robust costæ. Reported from fresh and brackish water. New to New Zealand.

NAVICULA CRYPTOCEPHALA Kütz. Plate 1, fig. 15.

Navicula cryptocephala Kütz., FR. HUSTEDT, Bacillar. (1930) 295, fig. 495.

Valve lanceolate, with attenuate ends. Length, 0.027 mm; breadth, 0.0068. Striæ slightly radiate, 17 or 18 in 0.01 mm. Infrequent. Reported from New Zealand.

NAVICULA PUPULA Kütz. var. **CAPITATA** Hust. forma. Plate 1, fig. 22.

Navicula pupula Kütz. var. *capitata* Hust., FR. HUSTEDT, Bacillar. (1930) 281, fig. 467c.

Valve linear-elliptic, with enlarged margin and attenuate broad ends. Length, 0.0136 mm; breadth, 0.0068. Striæ radiate, about 20 in 0.01 mm. Differs from the type in its smaller size. New to New Zealand.

NAVICULA CUSPIDATA Kütz. var. AMBIGUA (Ehr.) Cleve. Plate I, fig. 8.

Navicula cuspidata Kütz. var. *ambigua* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 268, fig. 434.

Valve elliptic-elongate, with subcapitate, rounded ends. Length, 0.064 mm; breadth 0.018. Striæ parallel, 15 in 0.01 mm. Infrequent. Reported from New Zealand.

PINNULARIA VIRIDIS (Nitzsch.) Ehr. var. RUPESTRIS (Hantz.) Cleve? Plate 1, fig. 34.

Pinnularia viridis (Nitzsch) Ehr. var. *rupestris* (Hantzsch.) Cleve, A. SCHMIDT, Atlas Diatom. (1876) pl. 46, figs. 38–44.

Valve elliptic, with slightly attenuate and rounded ends. Length, 0.0442 mm; breadth, 0.012. Striæ slightly divergent at the middle and convergent at the ends, 11 or 12 in 0.01 mm. Longitudinal bands indistinct. Rare. New to New Zealand.

PINNULARIA MICROSTAURON (Ehr.) Cleve. Plate I, fig. 21.

Pinnularia microstauron (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 320, fig. 582.

Valve linear-elliptic, with almost straight margin and slightly subrostrate ends. Length, 0.0442 mm; breadth, 0.009. Striæ divergent in the middle and convergent at the ends, 12 in 0.01 mm. Infrequent. New to New Zealand.

GOMPHONEMA SUBCLAVATUM Grun. Plate I, fig. 40.

Gomphonema subclavatum Grun., A. SCHMIDT, Atlas Diatom. (1902) pl. 237, fig. 34.

Valve subclavate, elliptical. Apex broader than attenuate end. Length, 0.0255 mm; breadth, 0.0051. Striæ robust, slightly radiate, 12 in 0.01 mm, with distinct isolated puncta. Infrequent. Reported from New Zealand.

GOMPHONEMA SUBCLAVATUM Grun. var. MONTANA Schum. Plate 1, fig. 13.

Gomphonema subclavatum Grun. var. *montana* Schum.? A. SCHMIDT, Atlas Diatom. (1902) pl. 238, figs. 1–3.

Valve minute, clavate, slightly biconstricted, with short-apiculate apex and narrow basis. Length, 0.022 mm; breadth, 0.0051. Striæ subradiate, 15 or 16 in 0.01 mm. Infrequent. New to New Zealand.

GOMPHONEMA PARVULUM (Kütz.) Grun. Plate 1, fig. 2, 11, and 12.

Gomphonema parvulum (Kütz.) Grun., FR. HUSTEDT, Bacillar. (1930) 372, 373, fig. 713a.

Valve subclavate, elliptical, tapering from the middle to the acute ends. Length, 0.0085 to 0.017 mm; breadth, 0.0051 to

0.0068. Striæ slightly radiate, 15 to 18 in 0.01 mm. Very common. Reported from New Zealand.

GOMPHONEMA PARVULUM (Kütz.) Grun. var. EXILISSIMA Grun. Plate 1, figs. 1 and 10.

Gomphonema parvulum (Kütz.) Grun. var. *exilissima* Grun., VAN HEURCK, Synopsis (1880) pl. 25, fig. 12.

Valve lanceolate, slightly clavate. Length, 0.022 mm; breadth, 0.0042 to 0.005. Striæ slightly radiate, 17 or 18 in 0.01 mm. Very common. New to New Zealand.

GOMPHONEMA ANGUSTATUM (Kütz.) Rabh. Plate 1, fig. 9.

Gomphonema angustatum (Kütz.) Rabh., FR. HUSTEDT, Bacillar. (1930) 373, fig. 690.

A little diatom with robust striæ and distinct isolated puncta. Valve subclavate, with apex broader than lower part of valve. Length, 0.0204 mm; breadth, 0.0051. Striæ 8 or 9 in 0.01 mm. Infrequent. Reported from New Zealand.

GOMPHONEMA ACUMINATUM Ehr. Plate 1, fig. 14.

Gomphonema acuminatum Ehr., FR. HUSTEDT, Bacillar. (1930) 370, fig. 683.

Valve clavate, biconstricted with apiculate apex. Length, 0.037 mm; breadth, 0.011. Striæ radiate, 11 in 0.01 mm. Isolated puncta distinct. Infrequent. Reported from New Zealand.

GOMPHONEMA CONSTRICTUM Ehr. Plate 1, fig. 3.

Gomphonema constrictum Ehr., FR. HUSTEDT, Bacillar. (1930) 377, fig. 714.

Valve clavate, with subtruncate-capitate apex and less broad obtusely truncate basis. Length, 0.0204 mm; breadth, 0.085. Striæ 12 in 0.01 mm. Infrequent. Reported from New Zealand.

EPITHEMIA SOREX Kütz. Plate 1, fig. 5.

Epithemia sorex Kütz., A. SCHMIDT, Atlas Diatom. (1904) pl. 252, figs. 22–28.

Valve lunate, with concave ventral and arcuate dorsal margins. Ends recurved and capitate. Length, 0.0306 mm; breadth, 0.0085. Common. Reported from New Zealand.

RHOPALODIA GIBBERULA (Ehr.) O. Müll. var. VAN HEURCKII O. Müll. Plate 1, fig. 24.

Rhopalodia gibberula (Ehr.) O. Müll. var. *Van Heurckii* O. Müll., A. SCHMIDT, Atlas Diatom. (1906) pl. 255, figs. 113–116.

Valve semilanceolate, with straight ventral and arcuate dorsal margins. Ends oblique and acute. Length, 0.0289 mm; breadth, 0.0068. Costæ 4, striæ 15 in 0.01 mm. Not common. Reported from brackish water. New to New Zealand.

RHOPALODIA NOVAE ZEALANDIAE Hustedt var. **VENTRICOSA** var. nov. Plate 1, fig. 35.

Valvis sublanceolatis, ventre directis, dorso convexis et arcuatis. Polis utrimque obliquis acutis et rotundatis. Striatis transversis delicatissime, 12 in 0.01 mm. Longis valvis 0.0476 mm; latis 0.0204. Habit in aquis dulcis stagnalis prope Napier, N. Z. Legit I. C. Edmundson.

Valve semilanceolate, with arcuate dorsal side, broader than type. Length, 0.0476 mm; breadth, 0.0204. Striæ 12 in 0.01 mm. Infrequent. The type is known from New Zealand.

HANTSCHIA AMPHIOXYS (Ehr.) Grun. Plate 1, figs. 17 and 20.

Hantzschia amphioxys (Ehr.) Grun., FR. HUSTEDT, Bacillar. (1930) 394, fig. 747.

Valve length, 0.0289 to 0.034 mm; breadth 0.0068. Costæ 6, striæ 15 to 18 in 0.01 mm. Several valves have been observed. Common. Reported from New Zealand.

NITZSCHIA THERMALIS Kütz. var. **INTERMEDIA** Grun. Plate 1, fig. 16.

Nitzschia thermalis Kütz. var. *intermedia* Grun., VAN HEURCK, Synopsis (1880) pl. 59, figs. 17–19.

Valve slightly concave in the middle. Length, 0.073 mm; breadth, 0.005. Ends oblique and attenuate. Costæ 10 to 12, striæ about 35 in 0.01 mm. Not common. New to New Zealand.

NITZSCHIA PALEA (Kütz.) W. Smith. Plate 1, fig. 34.

Nitzschia palea (Kütz.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 416, fig. 801.

Valve linear, with parallel margins and attenuate, subacute ends. Length, 0.034 mm; breadth, 0.0028. Costæ 13 to 15 in 0.01 mm. Striæ indistinct. Rare. Reported from New Zealand.

SURIRELLA ANGUSTATA Kütz. var. **CONSTRICTA** Hustedt. Plate 1, fig. 33.

Surirella angusta Kütz. var. *constricta* Hustedt, FR. HUSTEDT, Bacillar. (1930) 435.

Valve elliptic, slightly constricted in the middle. Ends attenuate and rounded. Length, 0.0272 mm; breadth, 0.0072. Costæ 7 in 0.01 mm. Rare. New to New Zealand.

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ILLUSTRATION

PLATE 1

FIG. 1. *Gomphonema parvulum* (Kütz.) Grun. var. *exilissima* Grun.
2. *Gomphonema parvulum* (Kütz.) Grun.
3. *Gomphonema constrictum* Ehr.
4. *Cocconeis placentula* Ehr.
5. *Epithemia sorex* Kütz.
FIGS. 6 and 7. *Synedra ulna* (Nitz.) Ehr.
8. *Navicula cuspidata* Kütz. var. *ambigua* (Ehr.) Cleve.
9. *Gomphonema angustatum* (Kütz.) Rabh.
10. *Gomphonema parvulum* (Kütz.) Grun. var. *exilissima* Grun.
FIGS. 11 and 12. *Gomphonema parvulum* (Kütz.) Grun.
13. *Gomphonema subclavatum* Grun. var. *montana* Grun.?
14. *Gomphonema acuminatum* Ehr.
15. *Navicula cryptocephala* Kütz.
16. *Nitzschia thermalis* Kütz. var. *intermedia* Grun.
17. *Hantzschia amphioxys* (Ehr.) Grun.
18. *Meridion circulare* Agardh var. *constricta* (Ralfs) Van Heur.
19. *Scenedesmus brasiliensis* Bohlin.
20. *Hantzschia amphioxys* (Ehr.) Grun.
21. *Pinnularia microstauron* (Ehr.) Cleve.
22. *Navicula pupula* Kütz. var. *capitata* Hust. forma.
23. *Diploneis Smithii* Breb.?
24. *Rhopalodia gibberula* (Ehr.) O. Müll. var. *Van Heurckii* O. Müll
25. *Meridion circulare* Agardh.
26. *Diploneis puella* (Schum.) Cleve forma.
27. *Diploneis subovalis* Cleve fo. *Novae Zealandiae* fo. nov.
28. *Trachelomonas volvocina* Ehr.
29. *Trachelomonas oblonga* Lemm.
FIGS. 30 and 31. *Trachelomonas Hamiltoniana* sp. nov.
32. *Trachelomonas hispida* (Perty) Stein var. *subarmata* Schröder.
33. *Surirella angustata* Kütz. var. *constricta* Hust.
34. *Pinnularia viridis* (Nitzsch) Ehr. var. *rupestris* (Hantzsch.) Cleve?
35. *Rhopalodia Novae Zealandiae* Hust. var. *ventricosa* var. nov.
36. *Nitzschia palea* (Kütz.) W. Smith.
37. *Achnanthes coarctata* Breb.
38. *Cyclotella Meneghiniana* Kütz. var. *Novae Zealandiae* var. nov.
39. *Synedra ulna* (Nitzsch) Ehr.
40. *Gomphonema subclavatum* Grun.

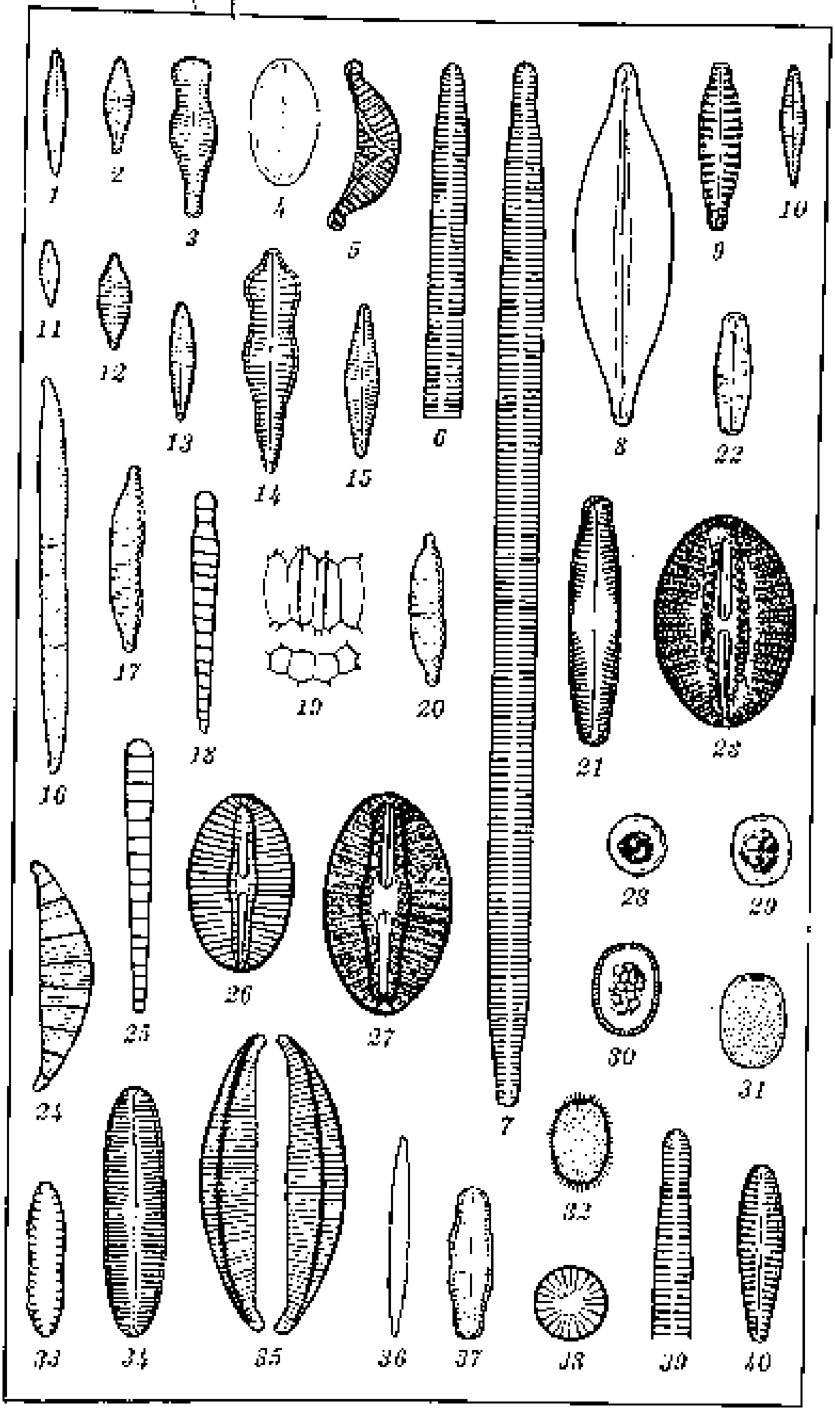
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PLATE 1.

SCOLYTIDÆ AND PLATYPODIDÆ: FAUNA PHILIPPINENSIS, V

By KARL E. SCHEDL

Of the Zoologisches Institut der Forstlichen Hochschule, Münden Hannover, Germany

TWO TEXT FIGURES

Through the courtesy of Dr. L. B. Uichanco, professor of entomology at the College of Agriculture, and Mr. A. de Mesa, assistant professor of forest entomology at the School of Forestry, and a forester, Bureau of Forestry, all in Laguna Province, Luzon, I was given the opportunity of examining their collections of Scolytidæ and Platypodidæ made in the Philippine Islands. The genera and species found in these collections are given below.

Genus CROSSOTARSUS Chapuis.

CROSSOTARSUS LECONTEI Chapuis.

LUZON, Laguna Province, Maquiling, February 1, 1934 (*L. Amon*), on *Cedrela odorata* L., July 29, 1931 (*L. Amon*), on *Diplodiscus paniculatus* Turcz., March 27, 1924 (*A. de Mesa*) on *Madhuca betis* (Blanco) Merrill, November 22, 1929 (*A. de Mesa*); Los Baños, February 29, 1915 (*D. R. Tuason*). MINDANAO, Zamboanga Province, Naganaga, March 23, 1930 (*A. de Mesa*) on *Pentacme contorta* (Vidal) Merr. et Rolfe, March 23, 1930 (*De Mesa and Tamayo*) on *Celtis philippensis* Blanco. MINDORO, Puerto Galera, Kalayaan, altitude 1,000 feet, April 23, 1935 (*S. M. Cendaña*).

CROSSOTARSUS FRACTUS Sampson.

LUZON, Laguna Province, Los Baños, August 17, 1922 (*S. M. Cendaña*) March, 1935 (*H. Varian*) on *Swietenia mahogani* Jacq.; Mount Maquiling, March 27, 1924 (*A. de Mesa*) on *Madhuca betis* (Blanco) Merrill.

CROSSOTARSUS OCTOCOSTATUS Schedl.

LUZON, Laguna Province, Los Baños, August 17, 1922 (*S. M. Cendaña*), November 16, 1929 (*D. Soriano*) on *Albizzia acle* (Blanco) Merrill; Mount Maquiling, altitude 110 meters, March 27, 1924 (*A. de Mesa*) on *Madhuca betis* (Blanco) Merrill.

CROSSOTARSUS BIFURCUS sp. nov.

Male.—Reddish brown, 3.5 millimeters long, 3.4 times as long as wide. This species, remarkable in the development of the declivity, has to be placed in a new group of the *Crossotarsi*, together with *C. octocostatus* Schedl and *C. derosus* Schedl, the main characters of which are: Lateral processes of apical margin of elytra similar to those in *Crossotarsi subdepressi*, but with alternate interspaces carinate towards declivity and ceasing as recessed pointed spines above declivital convexity. The group should be called *Crossotarsi alternante-depressi*.

Front flat, shiny, densely punctate along epistomal margin and towards articulations of antennæ, opaque and shallowly areolate above, medially with a short impressed striga, rounded towards vertex. Pronotum longer than wide (11 : 9), widest at posterior angles of femoral grooves, brightly shiny, sparsely beset with fine punctures, somewhat more densely so along base; median sulcus extremely fine, surrounded by a large cordiform patch of densely placed fine but deep punctures. Elytra wider than (10.2 : 9) and nearly twice as long as pronotum, shiny, widest at commencement of declivity, sides straight, feebly divergent, declivity commencing in posterior third, shortly convex; base carinate, disc with first four striæ sulcate near base, impressed behind, strial punctures indistinct, interspaces at first narrowly carinate, then convex and with scattered minute punctures; interspaces 2 and 4 widened towards and projecting as straight pointed spines over declivital convexity, interspaces 1, 3, and 5 narrowed and ceasing at commencement of latter, interspaces 6 and 7 united behind to form a lateral ridge which ceases short above sutural angle in a short downwards directed spine; declivital face opaque, finely rugulose, with indications of impressed rows, especially above, apical margin drawn out into two long downward-directed lobes which are pointed at their tips, thus producing a deep semicircular emargination at suture.

Female.—In size and proportions similar to male, front feebly depressed, shiny area narrower, median impressed striga longer. Pronotum stouter, punctures near apical margin coarse and dense, posterior angles of femoral grooves not so strongly developed. Elytra with base less carinate, interspaces 3 and 5 strongly elevated near base and covered with transverse rugæ, the others convex, all flattening out toward middle, striæ moderately impressed, remotely punctured, punctures large;

declivity convex, with a perpendicular flattened face below; striæ not visible on convexity, finely rugose, covered (especially on the perpendicular face) with short yellow pubescence.

Types in the collection of the Division of Forest Studies and Research, Bureau of Forestry, and in my own collection.

MINDANAO, Lanao Province, Kolambugan, November 20, 1929 (*A. de Mesa*) on *Parashorea malaanonan* (Blanco) Merrill; Kolambugan, Mangosinoro, October 20, 1929 (*A. de Mesa*): Zamboanga Province, Naganaga, October 9, 1930 (*A. de Mesa*), on *Dipterocarpus grandiflorus* Blanco; Lumarao, February 25, 1930 (*A. de Mesa*), on *Parashorea malaanonan* (Blanco) Merrill: Occidental Misamis Province, Misamis, February 25, 1930 (*A. de Mesa*), on *Shorea mindanensis* Foxworthy: Surigao Province, May 15, 1935 (*H. Varian*), on *Shorea negrosensis* Foxworthy.

Genus PLATYPUS Herbst

PLATYPUS SOLIDUS Walker.

LUZON, Laguna Province, Mount Maquiling (*H. F. Varian*), on *Peltophorum inerme* (Roxb.) Llanos, altitude 110 meters, March 27, 1924 (*A. de Mesa*), on *Madhuca betis* (Blanco) Merrill, January 8, 1934 (*L. Amon*), on *Sideroxylon macranthum* Merrill, December 26, 1934 (*L. Amon*), on *Macaranga bicolor* Muel.-Arg.; Los Baños, October 10, 1920 (*S. M. Cendaña*).

PLATYPUS EXCEDENS Chapuis.

LUZON, Laguna Province, Los Baños, December 20, 1929 (*R. Buhay*) on *Dysoxylum decandrum* (Blanco) Merrill; Mount Maquiling (*A. de Mesa*), on *Dipterocarpus grandiflorus* Blanco, April 14, 1933 (*L. Amon*), on *Alangium longiflorum* Merrill.

PLATYPUS LEPIDUS Chapuis.

LUZON, Laguna Province, Los Baños, 60 meters, April 2, 1934 (*L. B. Uichanco*); Mindoro Province, San Jose, April 11, 1923 (*L. B. Uichanco*).

PLATYPUS TURBATUS Chapuis.

LUZON, Laguna Province, Los Baños, February 12, 1913 (*C. S. Banks*); Mount Maquiling, altitude 110 meters, March 24, 1924 (*C. Rabaya*) on *Cassia javanica* Linn., altitude 200 meters, December 27, 1935 (*V. J. Madrid*).

PLATYPUS HYBRIDUS Schedl.

MINDANAO, Misamis Province, Misamis, November 22, 1929 (*A. de Mesa*), on *Diospyros pilosanthera* Blanco.

PLATYPUS SPECTABILIS Schedl.

MINDANAO, Zamboanga Province, Lumarao, February 24, 1930 (*A. de Mesa*), on *Dipterocarpus grandiflorus* Blanco.

Genus DACTYLOPALPUS Chapuis

DACTYLOPALPUS TRANSVERSUS Chapuis.

LUZON, Laguna Province, Mount Maquiling, March 17, 1932 (*A. G. Bautista*), on *Myristica philippensis* Lam.

Genus DIAMERUS Erichson

DIAMERUS MERINJAKI Sampson.

LUZON, Laguna Province, Mount Maquiling, altitude 200 meters, December 27, 1935 (*V. J. Madrid*).

The male, which has hitherto been undescribed, has the front planoconvex, with two slight depressions, one between the articulations of the antennæ, the other between the upper half of the eyes.

Genus SPHÆROTRYPES Blandford

SPHÆROTRYPES QUADRITUBERCULATUS Sampson.

LUZON, Laguna Province, Mount Maquiling, February 20, 1934 (*L. Amon*), on *Parashorea plicata* Brandis, January 20, 1934 (*L. Amon*), on *Pentacme contorta* (Vidal) Merrill et Rolfe.

Genus HYLESINUS Fabricius

HYLESINUS JAVANUS Eggers.

LUZON, Laguna Province, Mount Maquiling, March 30, 1932 (*Bautista*), on bark of *Ficus* sp.

Genus PHLŒSINUS Chapuis

PHLŒSINUS VAGANS Sampson.

MINDANAO, Zamboanga Province, Margosatubig, November, 1930 (*A. de Mesa*), on *Myristica philippensis* Lam.

PHLŒSINUS CRIBRATUS Blandford.

MINDANAO, Zamboanga Province, Naganaga, April 22, 1930 (*A. de Mesa*), lot No. 698, on *Myristica philippensis* Lam.

Genus CRYPHALUS Erichson

CRYPHALUS INDICUS Eichhoff.

LUZON, Laguna Province, Mount Maquiling, March 30, 1932 (*H. Varian*), on bark of *Ficus* sp.

CRYPHALUS HAGEDORNI Eggers.

LUZON, Laguna Province, Los Baños, February 25, 1918 (*A. G. Toquero*).

CRYPHALUS MINIMUS Eggers.

LUZON, Laguna Province, Mount Maquiling, January 30, 1921 (*M. A. Mariano*), on *Eugenia* sp.

Specimens that fit the description very well show sexual differences not mentioned by Eggers. The male has the apex of the pronotum more narrowly rounded, the asperities finer, and the asperate area not so sharply defined as the female. The elytral declivity is decidedly more strongly convex.

CRYPHALUS CAPUCINUS sp. nov. Text fig. 1.

Male.—Yellowish brown, 2.1 millimeters long, 2.2 times as long as wide. Dissection of one specimen shows that the series consists of males only. Pronotum similar to that of *C. indicus* Eichhoff, but the number of apical asperities and the general shape quite different. I could find no specimen that could be the female sex.

Front planoconvex, densely punctulate, with a faint longitudinal carina.

Pronotum wider than long, base distinctly bisinuate, moderately convex, summit behind middle densely finely punctate, with very small scattered asperities except on a rather broad and long area above anterior extension and on posterolateral corners; posterolateral angles not rounded, sides broadly arcuate, rather strongly extended apically, apex armed with two large and two smaller toothlike asperities; pubescence extremely short and intermixed with scattered long yellow hairs. Scutellum hardly noticeable. Elytra but little wider than and 1.7 times as long as pronotum, sides parallel in basal half, then gradually narrowed, broadly rounded behind, declivity commencing in middle, gradually convex; disc faintly striate-punctate, strial punctures very small, closely placed, striæ feebly impressed, more strongly so towards and on declivity, interspaces very densely, irregularly punctured, pubescence double, one set of hairs short, inclined, and yellow, the other long, erect, dark brown.

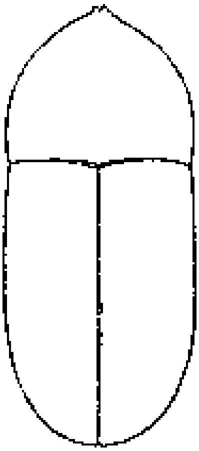

FIG. 1. *Cryphalus capucinus* sp. nov.; outline of male.

Types in the collection of the Division of Forest Studies and Research, Bureau of Forestry, and in my own collection.

LUZON, Laguna Province, Mount Maquiling, November, 1931 (*A. de Mesa*), lot No. 835, on *Cassia javanica* Linn.

Genus IPS DeGeer

IPS BICAUDATUS Eggers.

MINDANAO, Zamboanga Province, Naganaga, March 22, 1930 (*De Mesa, Reyes, and Tamesis*), lot No. 656, on *Vatica mangachapoi* Blanco.

Genus XYLEBORICUS Eggers

XYLEBORICUS IMITATOR Eggers.

LUZON, Laguna Province, Mount Maquiling, March 18, 1924 (*A. de Mesa*) on *Canarium multipinnatum* Llanos.

Genus XYLEBORUS Eichhoff

XYLEBORUS HYBRIDUS Eggers.

LUZON, Laguna Province, Los Baños, December 20, 1929 (*R. Bukay*) on *Dysoxylum decandrum* (Blanco) Merrill.

XYLEBORUS QUADRATICOLLIS Eggers.

LUZON, Laguna Province, Mount Maquiling, August 21, 1932 (*V. J. Madrid*).

XYLEBORUS NEPOS Eggers.

LUZON, Laguna Province, Los Baños, December 17, 1929 (*R. Bukay*), November 26, 1929 (*V. Parras*), on *Dysoxylum decandrum* (Blanco) Merrill.

XYLEBORUS CRASSITARSUS Schedl.

LUZON, Laguna Province, Mount Maquiling, altitude 200 meters, February 5, 1924 (*C. Rubaya*), on *Allaeanthus luzonicus* (Blanco) F. Vill.

XYLEBORUS DIVERSICOLOR Eggers.

LUZON, Laguna Province, Mount Maquiling, March 16, 1924 (*A. de Mesa*), on *Canarium multipinnatum* Llanos.

XYLEBORUS EXIGUUS Walker.

LUZON, Laguna Province, Mount Maquiling, January 15, 1935 (*H. F. Varian*), on *Swietenia mahogani* Jacq.

XYLEBORUS INDICUS Eichhoff.

LUZON, Laguna Province, Los Baños, December 26, 1929 (*V. Parras*), on *Dysoxylum decandrum* (Blanco) Merrill, December 2, 1929 (*R. Bukay*), on the same host.

XYLEBORUS TESTACEUS Walker.

LUZON, Laguna Province, Los Baños (*S. M. Cendaña, C. S. Banks, F. B. Santos, A. de Mesa, J. S. Versoza, M. Sulit*), December 10, 1929 (*P. San Buenaventura*) on *Artocarpus integra* (Blanco) Merrill. December 2, 1929 (*R. Buhay*), on *Dysoxylum decandrum* (Blanco) Merrill: Pangasinan Province, Mangaldan, December 18, 1935 (*S. M. Cendaña*). NEGROS, Silay-Hawaiian, November 8, 1928 (*C. T. Buligan*).

XYLEBORUS BADIUS Eichhoff.

LUZON, Laguna Province, Los Baños (*P. San Buenaventura, V. Parras, J. S. Versoza, C. S. Banks, F. B. Santos, L. B. Uichanco, A. A. Goco, R. B. Bautista*), March 12, 1929 (*R. Buhay*), on *Dysoxylum decandrum* (Blanco) Merrill.

XYLEBORUS SIMILIS Ferrari.

LUZON, Laguna Province, Los Baños, November 12, 1916 (*E. G. Collado*), August 15, 1915 (*F. W. Ashton*), November 24, 1923 (*M. A. Mariano*); Mount Maquiling, March 18, 1924 (*A. de Mesa*), on *Dillenia philippinensis* Rolfe.

XYLEBORUS OBTUSICOLLIS sp. nov. Text fig. 2.

Female.—Head and pronotum reddish brown, elytra distinctly darker (uniform in the whole series), 4.5 millimeters long, twice as long as wide. This species, which belongs in the *obtusus* group, has its closest allies in *X. bellus* Samps. and *X. obliquesectus* Eggers.

XYLEBORUS OBLIQUESECTUS Eggers.

Front convex, densely shallowly punctured, medially with a low longitudinal ridge. Eyes large, long-oval, deeply emarginate in front. Pronotum wider than long, base transverse, posterolateral angles rectangular, rounded; sides subparallel behind, semicircularly arcuate in front; apex narrowly extended, armed with two large asperities; transverse at summit, short behind middle; pronotum globose, anterior area steeply convex, perpendicular below, with rather few low asperities in cephalic half, finely granulate up to summit, posterior area densely finely punctate. Scutellum not visible. Elytra at base as wide as pronotum, at commencement of declivity distinctly wider and 1.5 times as long as pronotum, sides straight but divergent towards declivity, rather obliquely rounded behind, with a shallow notch at suture, declivity

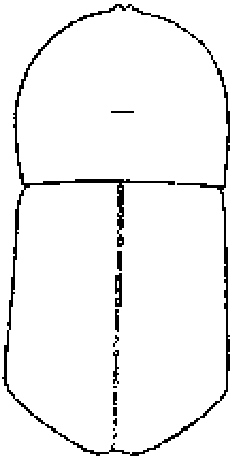

FIG. 2. *Xyleborus obtusicollis* sp. nov.; outline of female.

obliquely truncate but without well-defined margins and commencing distinctly behind middle; disc shiny, without pubescence except at extreme base, densely irregularly punctured; declivity planoconvex, with a shallow longitudinal impression near posterolateral corners, entire face irregularly finely punctured and with dense yellow and inclined pubescence.

Types in the collection of the Division of Forest Studies and Research, Bureau of Forestry, and in my own collection.

MINDANAO, Zamboanga Province, Naganaga, March 23, 1930 (*Tamayo, A. de Mesa*), lot No. 619, on *Vatica mangachapoi* Blanco.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Cryphalus capucinus* sp. nov.; outline of male.
2. *Xyleborus obtusicollis* sp. nov.; outline of femora.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

REVIEWS

Report on an Investigation into Maternal Mortality. Presented by the Minister of Health to Parliament by Command of His Majesty, April, 1937. London. Printed and Published by His Majesty's Stationery Office, 1937. 358 pp., maps, diagr., graphs, tables. Price, 5s. 6d.

This report, profusely illustrated with tables, graphs, maps, and diagrams, is a study made in England and Wales regarding the persistently stationary maternal mortality rate, in spite of improved medical, economic, and health conditions.

During the period 1925–1933 this stationary maternal mortality rate existed in England and Wales and 17 other countries not mentioned. The puerperal death rate is calculated on births and not on pregnancies, hence the rate is exaggerated because it includes deaths due to abortions. The puerperal death rate of England and Wales during the years 1933, 1934, and 1935, which respectively were 4.51, 4.60, and 4.10 per thousand, would correspondingly be reduced to 3.86, 3.94, and 3.51, if deaths due to abortion had been excluded. The reviewer agrees with the Report in its statement that the puerperal death rate should be calculated from the number of pregnancies and not from the number of births, as this gives an inaccurately higher maternal mortality, but does not agree with its opinion that the incidence of pregnancies cannot possibly be determined. This can be done if the compulsory registration of all abortions and miscarriages as well as all births is officially required.

As in America and other European countries, the chief causes of mortality in the 770 maternal deaths in 1934 which were the subject of investigation were, in the order of frequency: Sepsis, albuminuria and convulsions, and hæmorrhage. It is of significant interest that in Manila, at least during the period 1914–1934, hæmorrhage as a cause of puerperal mortality occupies second place in the order of frequency. Abortion caused

14 per cent of the puerperal death rate. More deaths from abortion occurred in married women but abortion was responsible for the higher maternal death rate of the unmarried.

Besides a detailed investigation on the particular circumstances attending each maternal death with a view to its preventability, the Report also cites the attempt to find the influence of certain conditions on puerperal mortality and the conclusions drawn therefrom.

The main recommendation of the Report is to place all obstetrical patients under the control of experts who will act in an advisory capacity or as consultants to medical practitioners engaged in midwifery and who should see to it that the best obstetrical skill is available to every maternity patient. Recommendations were also made for research on (*a*) the reliable prophylactic treatment of puerperal infection, (*b*) the influence of abortion on maternal morbidity and mortality and future child-bearing, and (*c*) the possible influence of dietary upon child-bearing.—H. A. S.

Maternal Deaths—The Ways to Prevention. By Iago Galdston. New York, The Commonwealth Fund, 1937. 115 pp. Price, $0.75.

This little book summarizes the maternal mortality problem in the United States and cites medical investigations and statistics gathered in New York city. Preventive measures are discussed. Many mothers will perhaps not have died in vain if the lessons taught by their tragic and untimely deaths are given effective application in the future. Among the lessons suggested by the author are adequate antepartum care, competent medical service, and well-equipped hospitals. Fifty per cent of the mortality rate can be prevented by the coöperation of medical men, social workers, and the public. Better instruction is needed by these various groups, and most emphatically by the public.

The Appendix illustrates the type of medical organization the large communities can create to improve the quality of obstetrical service rendered. This brief survey will be of interest to physicians, to health workers, and to laymen.—I. F.

To Drink or Not to Drink. By Charles H. Durfee. New York, Longmans, Green and Co., 1937. 212 pp. Price, $2.

Through this book the author has made a valuable contribution to the solution of a complex social problem caused by the unwise use of alcohol. The readers will get interesting facts concerning the influence of alcohol upon the psychology and health of human beings and society as a whole. The author is a noted psychologist, and the methods of treatment found in this book are the result of his personal experience based on an extensive psychoanalysis of the life and character of alcoholic persons coming from different walks of life.

This book gives us a clear picture of a problem drinker whose drinking becomes a habit and a social evil to him, to his home, and to society. With long years of experience inside and outside his institution the author has made extensive studies of the histories, causes, and treatment of typical cases of problem drinkers, and discusses them in detail in this book. He has shown that all the difficulties encountered among alcoholics can be conquered by means of the modern scientific methods of treatment, such as the application of psychic persuation, educational training, and constructive occupational therapy. All these methods of treatment constitute an important advance in the therapy of alcoholism. He proved by actual experience on his farm in Rhode Island the advantages of this method of therapy, and cites several cases in which complete cure was accomplished. To physicians, social workers, and laymen, this book will serve as an effective guide in fighting the social evils which arise from the abuse of alcohol.—P. J. A.

By-Effects in Salvarsan Therapy and Their Prevention with Special Reference to the Liver Function. By V. Genner. Copenhagen, Levin & Munksgaard, 1936. 358 pp. Price, $6.50.

Part I of this book contains a detailed presentation and analysis of by-effects in salvarsan therapy as they occurred in 5,526 syphilitic patients treated in the Dermatological Department of the Rigshospital, Copenhagen University, Denmark, from 1913 to 1932. Thorough discussions were made with citation of literature on the pathogenesis of the objective by-effects, such as erythema, jaundice, albuminuria, and joint complaint occurring in the salvarsan therapy on the different stages of syphilis. In Part II the author enumerates the different subjective by-effects of salvarsan therapy obtained by careful questioning as they occurred in his 316 out or dispensary patients. A great percentage of these subjective by-effects with few exceptions was checked or mitigated by injecting salvarsan in glucose solution. Two simple functional liver tests were applied on the dispensary patients with the object of determining the condition of the liver during the salvarsan therapy, before and after the occurrence of by-effects. Part III deals with other functional liver tests applied on 108 syphilitic patients under salvarsan treatment that could not be done on dispensary patients. The tests applied were: The determination of icterus index (Meulengracht), estimation of quinine resistant lipase in the blood (Rona), and Bauer's galactose tolerance test, for urobilinogen and for bile salts. From the results of these tests the author tried to reason out whether latent functional disturbances of the liver occurred under salvarsan therapy.

On the whole, the book is very valuable to those who are confronted with by-effects of salvarsan therapy.—F. G.

Selected Topics in Colloid Chemistry; With Especial Reference to Biochemical Problems. By Ross Aiken Gortner. Ithaca, New York, Cornell University Press, 1937. 169 pp., 35 figs., 38 tables. Price, $2.50.

This brief volume on "Colloid Chemistry" covers the lectures of the author when he held the George Fischer Baker Non-Resident Lectureship in Chemistry at Cornell University, 1935–1936.

The first part of the book gives the basic concepts of colloid chemistry including the fundamental properties of colloidal systems. The latter part treats of the author's explanation and viewpoints on such important subjects as have important bearing on biochemical problems, as electrokinetics, surface and interfacial phenomena, molecular orientation, and adsorption. The last and concluding chapter discusses "bound water," which the author believes is of first importance in the elucidation of living processes. The book includes 35 figures and 38 tables of data which are critically discussed.—F. L. R.

Latex in Industry. A New and Comprehensive Textbook. By Royce J. Noble. New York, The Rubber Age, 1936. 384 pp., illus. Price, $7.

This book gives in a brief but comprehensive manner the technology and chemistry of latex. It gives a condensed discussion of latex—its sources, preservation, and concentration. The latter portion of Part I covers such subjects as artificial latices, the compounding, coagulation, and vulcanization of latex, and the physical and chemical examination of latex. Part II of the treatise deals with the industrial applications of latex. Chapters XII to XVI describe the processes by which latex finds use in manufactured goods, as impregnation, spreading, dipping, molding, and electrodeposition. Paper treatment with latex, artificial leather, porous rubber and rubber thread, the manufacture of friction elements and adhesives, latex treatment of rugs, and the miscellaneous applications of latex are covered in the last part of the volume.

On the whole the present volume should be useful to workers in the field of rubber not only as a source of condensed information but also as an up-to-date reference. The wealth of the bibliography at the end of each chapter makes it a handy reference guide for those who desire to go into the literature of latex in greater detail.—F. L. R.

The Bed-Bug; its Habits and Life-History and How to Deal with It. By A. W. McKenny-Hughes. London, Printed by Order of the Trustees of the British Museum, 1937. 4th ed. 19 pp., front., illus. Price, 6d.

This pamphlet is a practical account of the bedbug, one of the most widely distributed house pests known. It takes up the external anatomy of the insects, its blood-sucking apparatus, life history, habits, mode of dissemination, relation to disease, and methods of control. Under the last item the eradication of minor and major bug infestations are discussed, and the promising results obtained with the use of heavy naphtha, a fumigant which is apparently not poisonous to human beings, are mentioned.—M. T.

An Introductory Course in Science for Colleges. I. Man and The Nature of His Physical Universe. II. Man and the Nature of His Biological World. By Frank Covert Jean, Ezra Clarence Harrah, and Fred Louis Herman. With the Editorial Collaboration of Samuel Ralph Powers. Boston, Ginn and Company, c1934. 2 vols. Price, $4.50.

Discussions on space and cosmic bodies are presented in a fascinating way in volume I of this work. The principal types of force and energy, like gravitation, heat, magnetism, electricity, and radiant energy, are treated from the point of view of pure science and their practical applications to human living through the use of machines and inventions. This volume ends with a study of the earth and its characteristics and features which make life upon it possible.

Plants, animals, synthesis and decomposition, evolution, and adaptation, genetics and heredity, and man's cultural development are discussed in volume II. Biology has changed man's ideas as to the nutritional needs of the body, the nature and extent of hormone regulation, and the means adopted by the organism to combat disease.

New discoveries and the further application of scientific principles to the needs of modern life affect fundamentally both the content of the curriculum and the methods of instruction.

The student acquires an adequate conception of the general principles of science and an appreciation of the relation of that particular science to his needs. The courses are organized from the point of view of the life needs of the general student rather than of the student who wishes to become a specialist.

The authors of this text have subscribed to the organization of generalized introductory courses in science which are presented in such a way as to help the student to orientate himself in his universe, to help to free him from superstition and prejudice, to teach him to rely upon established truth, and to appreciate the careful, logical methods employed by the scientist in arriving at trustworthy conclusions.

These two volumes are the result of four years experience in the classroom. The illustrations, questions, and references at the end of each chapter enhance the value of this book.—L. R.

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[New names and new combinations are printed in boldface.]

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